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2003 Environmental Restoration Contractor Revegetation Monitoring Report

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2003 Environmental Restoration Contractor Revegetation Monitoring Report

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EXECUTIVE SUMMARY

This report documents the progress of revegetation monitoring conducted for the period of April through August 2003. This is the fifth year of monitoring following revegetation efforts at the 316-5 Process Trenches and the 116-C-1 Restoration site. Fourth-year monitoring was conducted on the 116-B-1, 116-B-11, and 116-C-5 revegetation sites. Second-year data collections were gathered on the revegetated liquid sites in the 100-D/DR and 100-H Areas and the 600-23 and J. A. Jones sites in the 600 Area of the Hanford Site. First-year data collections were gathered from the 120-N-1 and -2 revegetation area following planting in January 2003 and the Environmental Restoration Disposal Facility (ERDF) Mitigation plantings on the Arid Land Ecology Reserve (ALE). Monitoring of these sites is conducted annually to ensure that the objectives of the revegetation efforts are accomplished, to note planting techniques that yield the greatest success, and to document successional recovery. It is important to remember that it typically takes 3 to 5 years before revegetation efforts show signs of success.

The 600-23 and J. A. Jones sites were backfilled in late summer 2001 and then revegetated in December 2001. Both areas were hydroseeded with a mixture of native seed collected from around the Hanford site. Triple 16 fertilizer was co-applied during seeding at 112 kg/ha and irrigated with 0.62 cm of water. The entire seeded area was mulched with grass straw, then crimped into the soil surface with a disk. The 600-23 site was planted with 140, 4-in.^{3} sagebrush (*Artemisia tridentata*) tublings and 150, 4-in.^{3} bitterbrush (*Purshia tridentata*) tublings. The J. A. Jones site was planted with 100, 4-in.^{3} sagebrush tublings and 130, 10-in.^{3} bitterbrush tublings. Vegetation surveys conducted in 2003 found 31 species on the 600-23 site and 33 species on the J. A. Jones site. Shrub survival data gathered on the 600-23 site in May 2003 found survival rates consistent with 2002 collections, and was calculated at 83.6% for sagebrush and 78.2% for bitterbrush. Initial shrub survival data were collected in August 2002 on the J. A. Jones site with resulting survival rates of 89.2% for sagebrush and 39% for bitterbrush. In May 2003 shrub survival data were collected and calculated at 81.1% for sagebrush and 19.5% for bitterbrush.

Executive Summary

The 316-5 Process Trenches were remediated between mid-1997 and early 1998. Eighty percent of the remediated trench area was regraded and contoured with the surrounding soils. During the fall of 1998, the recontoured area was broadcast seeded with 50 kg/ha crested wheatgrass (*Agropyron cristatum*). Wheat (*Triticum sp.*) straw was used as mulch and crimped into the soil. Fifth-year monitoring was conducted in June 2003 and identified 33 species. The most abundant species on the trench was crested wheatgrass with 22.3% canopy cover, an increase of 1.4% from measurements collected in the 2002 surveys. Cheatgrass (*Bromus tectorum*) canopy cover decreased 6.4% from 2002 data collections. Several shrub species including bitterbrush, rabbitbrush (*Chrysothamnus nauseosus*), and sagebrush have moved onto the revegetated site from adjacent undisturbed areas.

The 116-C-1 revegetation was conducted as a demonstration project to evaluate practical methods for revegetating remediated sites with native species. The 116-C-1 site was backfilled with naturally occurring sand and cobble from a nearby borrow pit, and was the planting medium for two out of four planting treatment methods. The remaining two treatments used topsoil salvaged from the construction area of the ERDF. In November 1998, a native seed mix was distributed across the site. Cryptobiotic soil/dust was also spread on the eastern half of the site to inoculate the soil surface, and then wheat straw mulch was applied across the planted area at an approximate rate of 6.7 metric tons/ha, then crimped into the soil surface. Two hundred and one sagebrush tublings were planted across the site in groups of three and irrigated. Irrigation was broadcast over one-half of the cobble substrate and one-half of the topsoil substrate. Thirty-one species were observed across the site this year, of which 23 were native. The planted sagebrush tublings had an average survival rate of 77%, with the highest survival on the nonirrigated cobble treatment at 90.9%.

The 116-B-1, 116-B-11, and 116-C-5 sites were seeded in December 1999. Three different fertilizer formulas were applied to backfill areas. The native seed mix and fertilizer treatments were applied with a hydroseeder. The entire seeded area was mulched with straw and irrigated with 0.62 cm of water. In December 2000, 2,600 sagebrush tublings were planted across the area. Vegetation analysis conducted in May 2003 found 29 species across the sites, 18 of which

were native. Sandberg's bluegrass (*Poa sandbergii*) continues to have the greatest canopy cover across all treatment areas. Species diversity is highest on the 116-C-5 site, which received a combination of Triple 16 and micronutrient fertilizers.

The 100-D/DR and 100-H liquid wastes were revegetated in November and December 2001. The entire backfilled area at 100-D/DR (27.9 ha) and 100-H (22.2 ha) were broadcast seeded with a hydroseeder and irrigated with 0.62 cm of water. The entire seeded area was mulched with grass straw and crimped into the soil surface with a disk. Initial vegetation analysis at the 100-D/DR and 100-H areas identified 36 and 30 species, respectively, across the sites.

The 120-N-1 and -2 sites were backfilled in December 2002 then broadcast seeded with a mix that included Sandberg's bluegrass, needle-and-thread grass (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), and thickspike (*Agropyron dasytachyum*) and bluebunch wheatgrass (*Agropyron spicatum*) in mid-January 2003. The 1.6-ha area was separated into four treatment areas. A combination of two separate fertilizer treatments and two types of mulch were used. The entire area was broadcast seeded and irrigated with 0.62 cm of water. One-half of the site was fertilized with Triple 16 fertilizer, and the other half was fertilized with Biosol, an organic slow-release fertilizer. One-half of the Triple 16-treated area and one-half of the Biosol-treated area were mulched with grass straw, then crimped into the soil surface. The remaining area was mulched with industry-standard hydromulch fiber. Initial vegetation surveys conducted in June 2003 indicate increased seedling emergence on the straw-mulched treatment areas when compared to the hydromulched area.

In December 2002, the U.S. Department of Energy, Richland Operations Office and the U.S. Fish and Wildlife Service cooperated on a compensatory mitigation planting project on the ALE Reserve for the original construction of ERDF cells 1 and 2, where approximately 68.8 ha of mature sagebrush habitat. The mitigation project included three separate planting elements: a native grass seed planting, shrub seedling planting, and a native grass plug planting, which will be completed this fall. Approximately 64.7 ha were broadcast seeded with 22 kg/ha native grass seed in mid-December, then harrowed with a tractor-drawn implement. Approximately 139,000

shrub seedlings were planted across 125.5 ha in early December 2002. The shrubs planted included 10,300 10-in.^{3} tublings, 28,100 4-in.^{3} tublings, and 93,000 bareroot sagebrush. Also planted were 6,000 gray rabbitbrush tublings and 6,000 green rabbitbrush (*Chrysothamnus viscidiflorus*) tublings. The shrubs were planted in three separate areas and sagebrush plants were monitored for survival. First-year shrub survival data were collected in mid-August. The bareroot sagebrush had 57.9% survival; the 10-in.^{3} tublings had 65.6% survival and the 4-in.^{3} tublings had 76.7% survival.

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METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	Millimeters
inches	2.54	Centimeters
feet	0.305	Meters
yards	0.914	Meters
miles	1.609	Kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
Millimeters	0.039	Inches
Centimeters	0.394	Inches
Meters	3.281	feet
Meters	1.094	yards
Kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
Hectares	2.47	acres
Mass (weight)		
Grams	0.035	ounces
Kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
Milliliters	0.033	fluid ounces
Liters	2.1	pints
Liters	1.057	quarts
Liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit

1.0 INTRODUCTION

This report contains a compilation of vegetation monitoring data results that were collected in the spring and summer of 2003 from the Environmental Restoration Contractor's (ERC's) revegetation and mitigation areas on the Hanford Site. The monitoring sites included in this report are the 316-5 Process Trenches; the 116-C-1, 116-B-1, 116-B-11, and 116-C-5 sites; the revegetated area at the 100-D/DR, 100-H, 120-N sites; and ERDF cells 1 and 2 mitigation planting on the ALE (Arid Lands Ecology Reserve). The locations of these sites are shown in Figure 1.

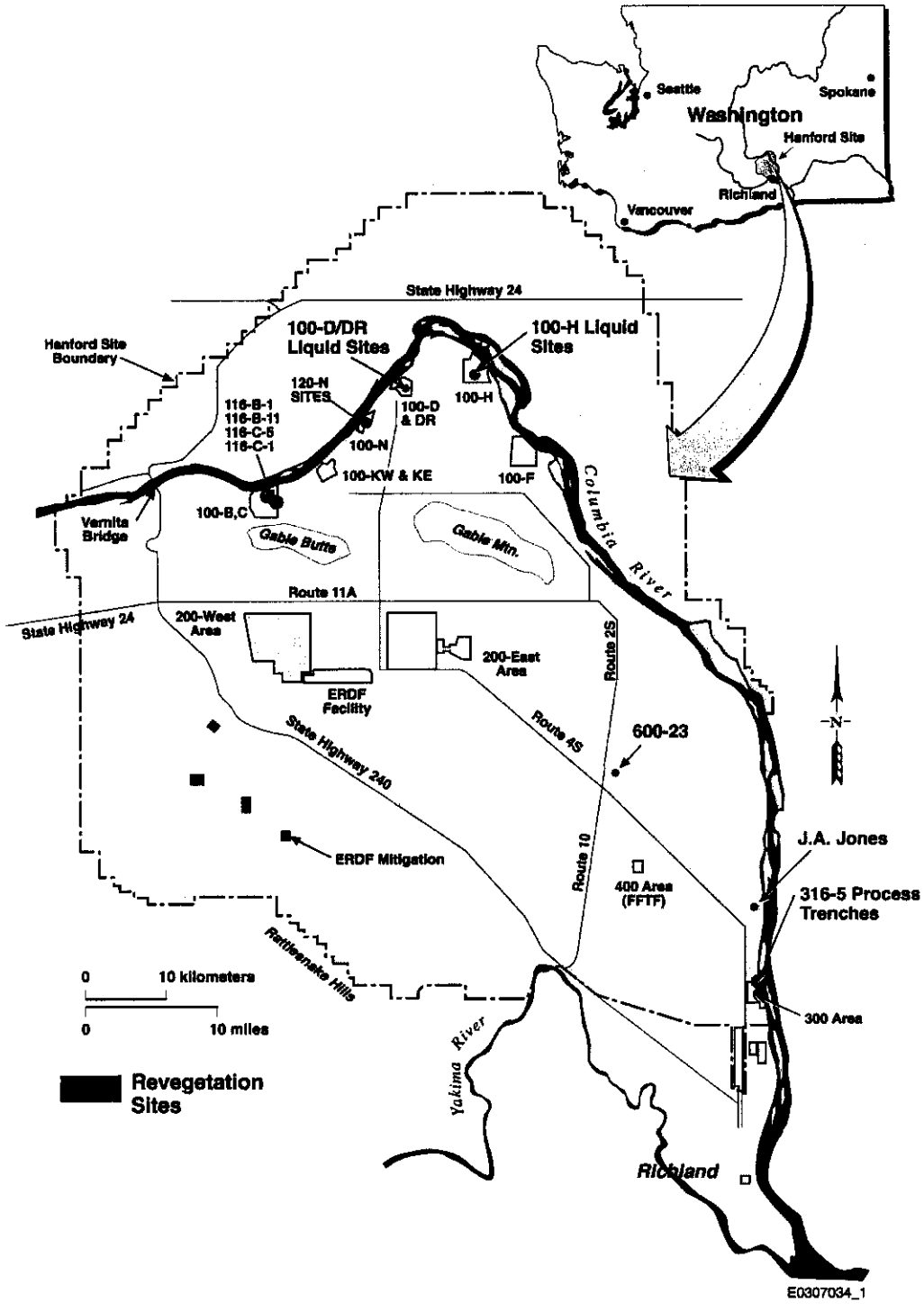
The extent of each revegetation effort varied, depending on the surrounding habitat, existing conditions, and future land use designation of the area. The purpose of monitoring revegetation efforts is to measure the progress of plant succession, and in some cases, to evaluate the success of different planting techniques. Each area is discussed separately in this report and includes a brief description of the revegetation activities and the results from the 2003 monitoring efforts and data collection activities.

This report provides fifth-year monitoring results for the 116-C-1 restoration site and the 316-5 Process Trenches; fourth-year vegetation monitoring results for the 116-B-1, 116-B-11, and 116-C-5 restoration areas; second-year data collection from monitoring efforts on the 100-D/DR and 100-H Area liquid waste sites, the 600-23, and the J. A. Jones sites; and first-year data for the 120-N sites and ERDF cells 1 and 2 mitigation planting. Results from previous years' monitoring are provided in reports for each respective year (Johnson 2002, Johnson 2001, Johnson et al. 2000, and Gano et al. 1999). The measurement data from the previous revegetation monitoring reports are summarized in Appendices A, B, C, and D of this report.

1.1 METHODS USED TO EVALUATE VEGETATION RECOVERY

Vegetation monitoring during 2003 consisted of measuring the canopy cover of all plant species found on a site, the frequency of occurrence, and the survival of transplanted sagebrush and bitterbrush. All values were then converted to percentages. Canopy cover and frequency measurements were obtained using the methods described in *Steppe Vegetation of Washington* (Daubenmire 1970). Canopy coverage is defined in Daubenmire (1970) as "the percentage of ground surface included in the vertical projection of a polygon drawn around the extremities of undisturbed foliage of a plant." This method provides a measure of the amount of ground covered by each species. Because it is possible for species to overlap one another in dense stands of vegetation, total measured vegetative cover can exceed 100%. Within each location, a series of plot frames were analyzed for the canopy cover of each species present. Frequency is represented as the percentage of occurrences that a species is observed in the number of plot frames measured. For example, if a species was represented in 10 out of 25 plot frames, its frequency would be 10/25 x 100 = 40%.

Figure 1. Hanford Site Showing Locations of Revegetation Sites.



The relative magnitude of a frequency rating in comparison to a canopy coverage rating provides an index of species distribution and its influence within a vegetation community. At sites where shrubs were planted, the survival rate was measured by counting a representative number of plants at the site, determining if the plants were dead or alive, and then calculating the percent survival rate.

This report uses taxonomic nomenclature from *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1973). Some of the plant taxonomic names have been updated, and the revised names are provided in Appendix E of this report. Plant identification was conducted using the nomenclature in Hitchcock and Cronquist (1973) and also in *Vascular Plants of the Hanford Site* (Sackschewsky et al. 2001).

The type and extent of each revegetation effort is based on the location of the project and the future land use designation of that area. The objective of revegetating the 116-C-1 site was to stabilize the soils and initiate the establishment of native species. The restoration plan for the site was developed as a demonstration project to evaluate the effect of soil type and supplemental irrigation on native plant establishment and shrub survival. The results of the monitoring efforts indicate that these objectives have been met and that monitoring can be discontinued at the 116-C-1 site.

In long-range planning, portions of the 300 Area have been designated for future industrial land use. Therefore, the objective of the 316-5 Process Trenches revegetation was to stabilize the soils with crested wheatgrass (*Agropyron cristatum*). The objective of revegetation at most remedial action sites is to restore the land to plant communities dominated by native plants that will eventually provide wildlife habitat. Secondary objectives often include using different planting methods and techniques to improve success, while incorporating experience and knowledge gained from previous plantings. The secondary objective of revegetation efforts for the 116-B-1, 116-B-11, and 116-C-5 sites was to evaluate the effectiveness of different fertilizer treatments on the success of native species establishment in rocky, pit run soils; while the secondary objective of revegetation on the 120-N sites was to evaluate the effect of various mulch and fertilizer types on grass establishment in these coarse soils.

Success criteria differ for each site based upon the soil types and microclimatic conditions. For example, sandy areas promote species with recovery rates and plant densities different from those found in rocky soils; therefore, the criteria for judging success will vary. All sites will be evaluated based on the plant canopy cover, plant community composition, and survival and growth rates of the transplanted shrubs. These criteria are detailed in the *Revegetation Manual for the Environmental Restoration Contractor* (McLendon et al. 1997). A revegetation effort will be considered successful if the area is stabilized to prevent erosion and is dominated by recovering stands of native sagebrush, forbs, and grasses. Areas identified for future industrial use will be stabilized, but instead of native species, wheatgrass (*Agropyron*) will likely be planted in these areas because of the potential for future land disturbance.

2.0 600 AREA REVEGETATION

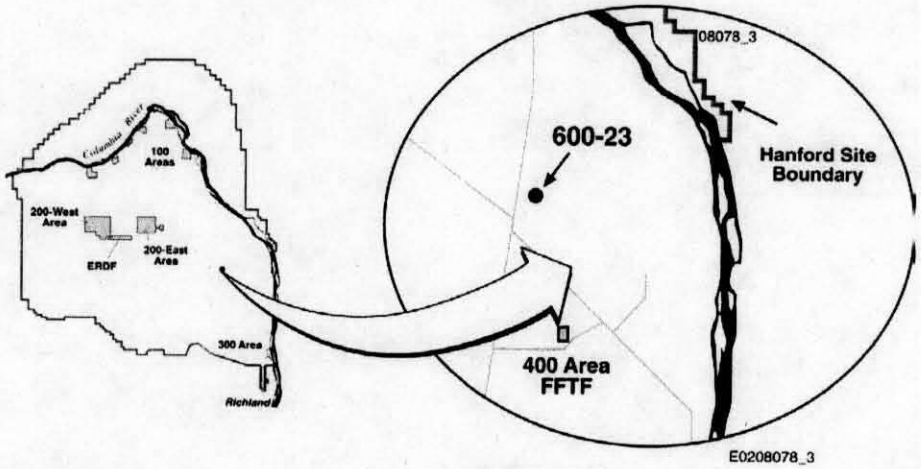
2.1 600-23 AND J. A. JONES SITES

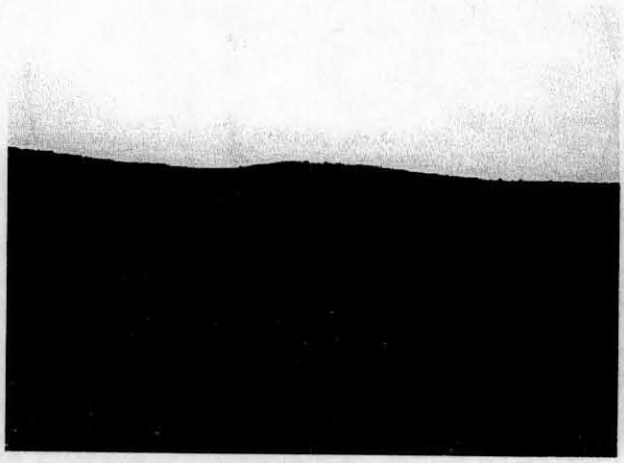
The 600-23 and J. A. Jones sites were remediated as part of the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-F-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (EPA et al. 1999). The 600-23 site is located north of the Hanford Site's Wye Barricade, along Route 2 south, and is within the pit 11 boundary (Figure 2). The J. A. Jones site is located north of the 300 Area (Figure 3). Both sites were used for the disposal of construction waste and miscellaneous debris. Prior to remediation, the 600-23 site was dominated by cheatgrass and Russian thistle, with occurrences of snow buckwheat and bitterbrush. The J. A. Jones site was dominated by cheatgrass and gray rabbitbrush with some Sandberg's bluegrass and bitterbrush. The area surrounding the J. A. Jones site is mature sagebrush and is identified as a Level III resource in the *Hanford Site Biological Resources Management Plan* (DOE-RL 2001). The goal of each revegetation effort was to stabilize the soils and initiate vegetative recovery.

The areas disturbed by remedial action activities include a 0.78-ha area at the 600-23 site and a 0.4-ha area at the J. A. Jones site. Both sites were revegetated under *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998) Milestone M-16-41C in mid-December 2001. Both areas were planted within months of being recontoured to the surrounding terrain. Both areas were hydroseeded with a native seed mix collected from the Hanford Site. The entire revegetated area had 112 kg/ha of Triple 16 fertilizer co-applied during seeding and irrigated with 0.62 cm of water. The seeded areas were mulched with straw at a rate of 4.5 metric tons/ha, then crimped into the soil surface with a disk. The 600-23 site was planted with 140, 4-in.^{3}sagebrush tublings and 150, 4-in.^{3} bitterbrush tublings. The J. A. Jones site was planted with 100, 4-in.^{3} sagebrush tublings and 130, 10-in.^{3} bitterbrush tublings. All bitterbrush plants were protected with biodegradable mesh tubes and anchored with bamboo to prevent browsing by deer.

The second-year vegetation survey was conducted on the 600-23 site on May 6, 2003 (Figure 2). Thirty-one species were identified on the site; 10 more species than were observed in 2002. Of the species identified, 11 were planted in 2002 (Table 1). Species that were planted and observed for the first time this year included stalk-pod milkvetch (*Astragalus sclerocarpus*), sand beardtongue (*Penstemon acuminatus*), Cusick's sunflower (*Helianthus cusickii*), and gray rabbitbrush (*Chrysothamnus nauseosus*). The total cover increased 8.3% from the 2002 survey, with an increase in cheatgrass cover and a reduction in Russian thistle cover. Shrub survival of both sagebrush and bitterbrush remains consistent with last year's calculated survival rate at 83.6% and 78.2%, respectively (Table 2).

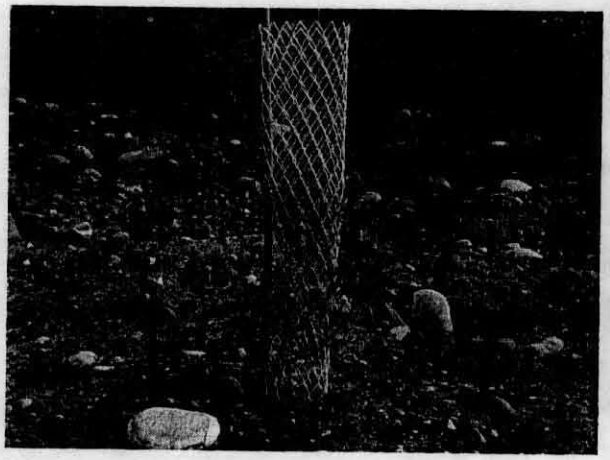
Figure 2. 600-23 Site.



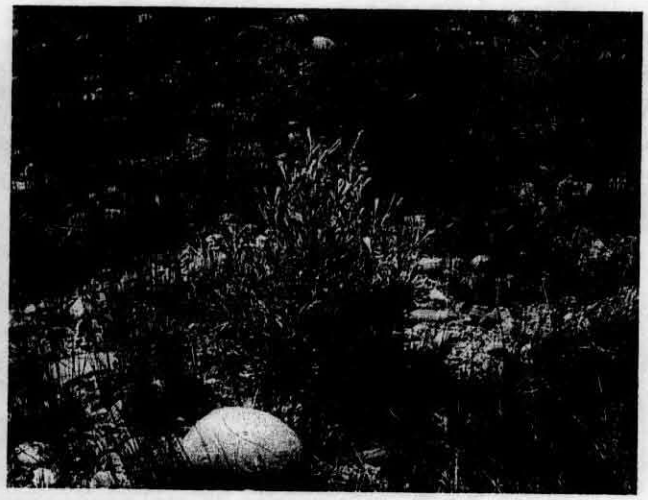


Preremediation, October 2000

Revegetated Area, May 2003

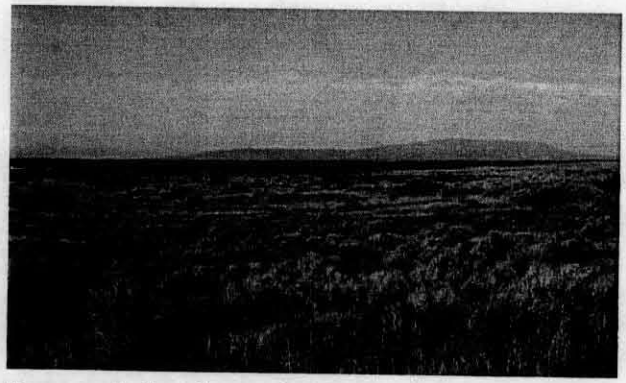


Bitterbrush Growing Outside of the Protective Mesh Tube, May 2003

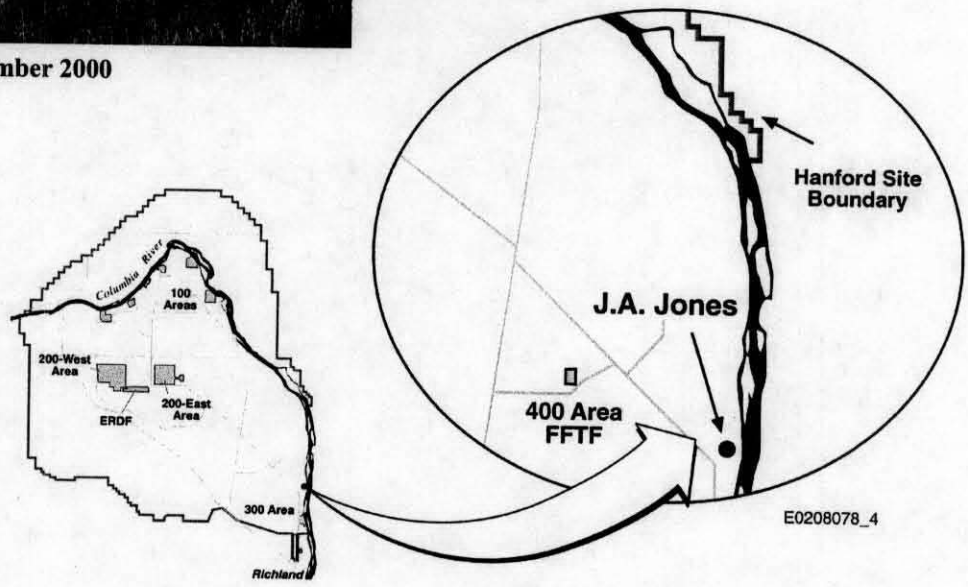


December 2001 Planted Sagebrush, May 2003

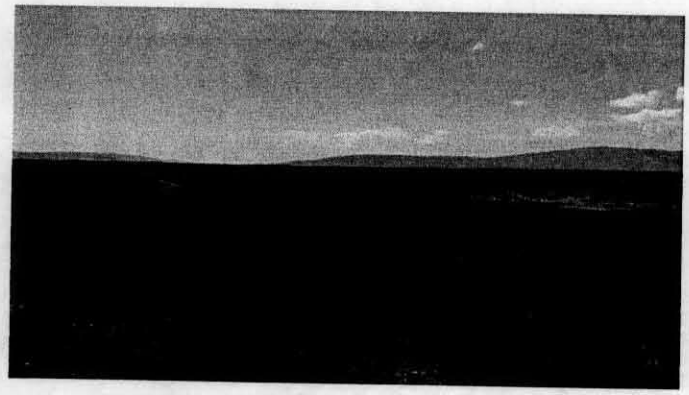
Figure 3. J. A. Jones Site.



Preremediation, September 2000



December 2001 planted Sagebrush, May 2003



Revegetated Area, May 2003

Table 1. Percent Canopy Cover and Frequency of Occurrence on the 600-23 Site in 2003.

Species	% Cover	% Frequency
Vulpia myuros[a] (Rattail fescue)	19	92
Poa sandbergii (Sandberg's bluegrass)	2.6	84
Bromus tectorum[a] (cheatgrass)	5.8	80
Salsola kali[a] (Russian thistle)	1.8	52
Achillea millefolium (yarrow)	0.6	24
Melilotus alba[a] (sweetclover)	0.1	4
Eriogonum niveum (snow buckwheat)	0.1	4
Stipa comata (needle-and-thread grass)	0.3	12
Agropyron sp. (wheatgrass)	4.2	52
Artemisia tridentata (sagebrush)	X	X
Festuca octoflora (slender sixweeks)	1.3	32
Gilia leptomeria (Great Basin Gilia)	X	X
Sisymbrium altissimum[a] (tumblemustard)	0.9	36
Holosteum umbellatum[a] (jagged chickweed)	0.1	4
Lactuca seriola[a] (prickly lettuce)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Ambrisia acanthicarpa (bur ragweed)	X	X
Poa bulbosa[a] (bulbous bluegrass)	0.8	12
Chaenactis douglassii (hoary falseyarrow)	X	X
Purshia tridentata (bitterbrush)	X	X
Machaeranthera canescens (hoary aster)	0.1	4
Draba verna (spring whitlow)	0.6	24
Epilobium panuculatum (tall willowherb)	0.3	12
Astragalus sclerocarpus (stalk-pod milkvetch)	0.1	4
Phacelia linearis (threadleaf scorpionweed)	0.1	4
Penstemon acuminatus (sand beardtongue)	X	X
Layia grandulosa (white daisy tidytips)	X	X
Helianthus cusickii (Cusick's sunflower)	X	X
Erodium cicutarium[a] (storksbill)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	X	X
Bare soil	53.2	100
Litter	19.6	100
Total cover (does not include bare soil or litter)	**19.8**	

[a] Introduced species.
X = present but not counted in plot frames

Table 2. Percent Survival Rate of Transplanted Shrubs.

Site	1999	2000	2001	2002	2003
116-C-1					
Non-irrigated cobble	100	95.5	95.4	93.9	90.9
Irrigated cobble	91.7	86.1	91.6	88.8	83.3
Non-irrigated topsoil	83.3	61.9	64.2	61.9	57.1
Irrigated topsoil	78.9	75.4	68.4	71.9	70.2
116-C-5	--	--	99	98.9	--
600-23					
Sagebrush	--	--	--	83.6	83.6
Bitterbrush	--	--	--	78.2	78.2
J. A. Jones					
Sagebrush	--	--	--	89.2	81.1
Bitterbrush	--	--	--	39	19.5
100-D/DR					
Sagebrush	-	--	--	93.8	87.8
100-H					
Sagebrush	--	--	-	59.8	59
ERDF mitigation					
10-in.^{3} sagebrush	--	--	--	--	65.6
4-in.^{3} sagebrush	--	--	--	--	76.7
Bareroot sagebrush	--	--	--	--	57.9

The second-year vegetation analysis was conducted in early May 2003 on the J. A. Jones site. The survey identified 33 species, 14 of which were included in the seed mix. Sandberg's bluegrass and cheatgrass covers increased 18% and 6.7%, respectively, this year. Russian thistle and tumblemustard covers decreased 10.3% and 11.9%, respectively, from 2002 data collections (Table 3). Survival of both planted sagebrush and bitterbrush seedlings was reduced compared to 2002. Sagebrush survival fell from 89.2% to 81.1%, and bitterbrush survival also fell from 39% in 2002 to 19.5% this year. Reduced bitterbrush survival could be contributed to the rapid establishment and subsequent competition from the other species on the site (Figure 3).

Table 3. Percent Canopy Cover and Frequency of Occurrence on the J. A. Jones Site in 2003.

Species	% Cover	% Frequency
Argropyron dasytachum (thickspike wheatgrass)	5.4	44
Bromus tectorum[a] (cheatgrass)	12.9	96
Salsola kali[a] (Russian thistle)	1.4	56
Poa sandbergii (Sandberg's bluegrass)	20.2	100
Achillea millefolium (yarrow)	1.6	44
Amsinckia lycopsoides (tarweed fiddleneck)	8.1	92
Artemisia tridentata (big sagebrush)	X	X
Purshia tridentata (bitterbrush)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Eriogonum niveum (snow buckwheat)	0.2	8
Erodium cicutarium[a] (storksbill)	2	60
Lactuca serriola[a] (prickly lettuce)	X	X
Festuca octoflora (slender sixweeks)	1.4	36
Sisymbrium altissimum[a] (tumblemustard)	2.1	64
Machaeranthera canescens (hoary aster)	0.2	8
Chaenactis douglasii (hoary falseyarrow)	0.1	4
Microsteris gracilis (pink microsteris)	0.2	8
Penstemon acuminatus (sand beardtongue)	X	X
Balsamorhiza careyana (Carey's balsamroot)	X	X
Phlox longifolia (longleaf phlox)	0.1	4
Ambrosia acanthicarpa (bur ragweed)	1.2	48
Draba verna (spring whitlowgrass)	1.2	28
Holosteum umbellatum[a] (jagged chickweed)	2.1	84
Cryptantha circumscissa (matted cryptantha)	0.1	4
Erysimum asperum (wallflower)	0.2	8
Stipa comata (needle-and-thread grass)	0.4	16
Hordeum leporinum[a] (Hare barley)	0.6	4
Erigeron poliospermus (cushion fleabane)	0.1	4
Astragalus succumbens (crouching milkvetch)	0.1	4
Gilia leptomeria (Great Basin Gilia)	X	X
Descurania pinnata (western tansymustard)	0.1	4
Epilobium paniculatum (tall willowherb)	X	X
Tragopogon dubius[a] (yellow salsify)	X	X
Bare soil	44.2	100
Litter	22.6	100
Total cover (does not include bare soil or litter)	62.1	

[a] Introduced species.
X = present but not counted in plot frames

3.0 300 AREA

3.1 316-5 PROCESS TRENCHES

The 316-5 Process Trenches became active in 1975 as a replacement for the North and South Process Pond system in the 300 Area (Figure 4). The trenches received process effluent from the uranium fuel fabrication facilities and liquid from the laboratories that were determined to be below discharge limits in the 300 Area. The 316-5 Process Trenches were two parallel, unlined trenches, about 468 m long, 3 m wide, and 3.7 m deep, spaced 15 m apart. The trenches were covered with screen to minimize access by birds to the sediments in the bottom of the trenches.

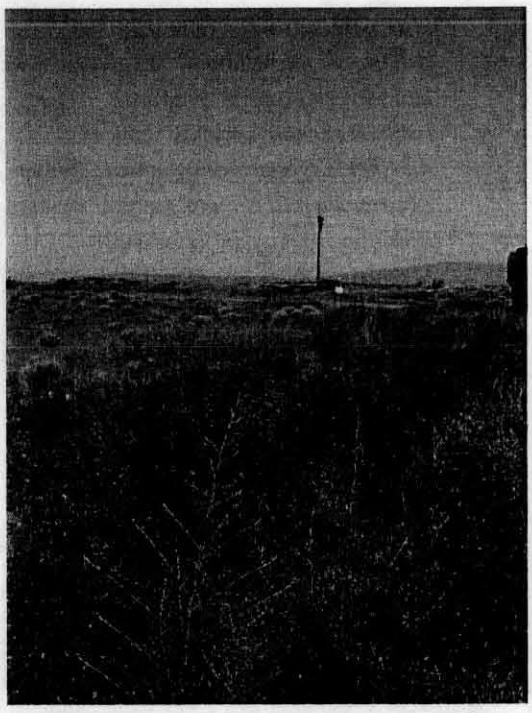
Trench remediation activities were initiated in July 1997 and completed in February 1998. Approximately 34,000 metric tons of contaminated soil and debris were excavated and shipped to the ERDF. The process trenches were regraded and contoured with the surrounding terrain in late 1998. A southern portion of the trenches was not graded due to the close proximity of the North Process Pond, which was yet to be remediated. This portion of the trench will be completed with the remaining process pond work in fiscal year 2004. In an effort to protect fragile native habitat adjacent to the 618-5 Burial Ground in 2002, regulators approved the storage of overburden materials from the remedial action work to be placed on a portion of the revegetated area of the 316-5 Process Trenches. The soil staging area will be revegetated with the remaining 300-FF-1 sites.

In long-range planning, this portion of the 300 Area has been designated as future industrial land use (EPA et al. 1996); therefore, the area was broadcast seeded with 50 kg/ha of crested wheatgrass. Straw mulch was distributed across the site and crimped with a serrated disk.

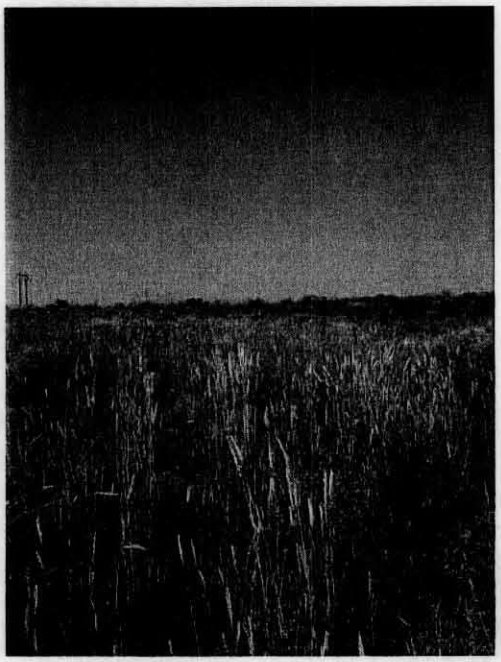
On June 17, 2003, thirty-three species were observed on the site, of which 23 were native. Three native species were observed for the first time on the trench this year: green rabbitbrush, Indian ricegrass, and tall willowherb. Crested wheatgrass cover remains consistent with last year's measurement of 22.3% cover, while cheatgrass cover fell from 17.3% in 2002 to 10.9% this year (Table 4). Several shrub seedlings including bitterbrush, sagebrush, and rabbitbrush were noted along the perimeter of the site, because the undisturbed shrub community adjacent to the site is providing the trench with a seed source. The increase of native species observed each year, movement of shrubs onto the trench, and the maturity of the crested wheatgrass indicates that the site is continuing to recover and stabilize. Because this site has demonstrated increasing recovery, it will not require vegetation monitoring beyond the current fifth year of data collection.

Figure 4. 316-5 Process Trenches.

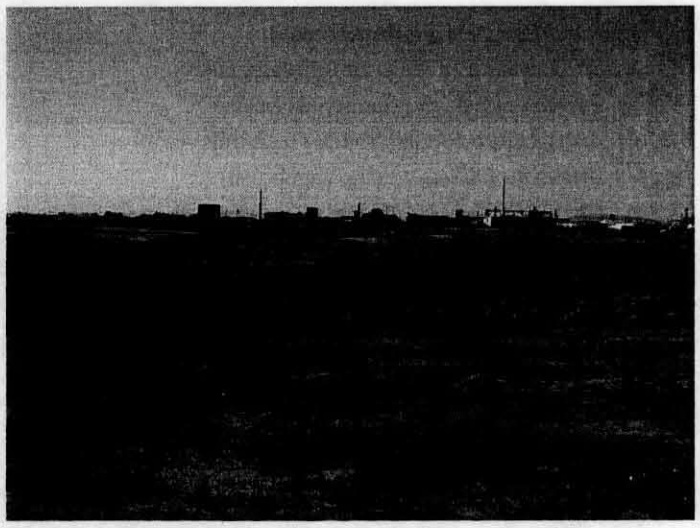
316-5 Process Trenches Remediation, 1998



Dune Scurfpea Volunteering onto the Site, June 2003



Crested Wheatgrass, June 2003



Rabbitbrush Volunteering onto the Site, June 2003

Table 4. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trench in 2003.

Species	% Cover	% Frequency
Bromus tectorum[a] (cheatgrass)	10.9	92
Salsola kali[a] (Russian thistle)	0.1	4
Ambrosia acanthicarpa (bur ragweed)	0.5	20
Microsteris gracilis (annual phlox)	0.7	28
Holosteum umbellatum[a] (jagged chickweed)	3.4	76
Draba verna (spring whitlow)	1.7	68
Lactuca seriola[a] (prickly lettuce)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	1.5	40
Sisymbrium altissimum[a] (tumblemustard)	0.1	4
Erodium cicutarium[a] (storksbill)	5.7	72
Machaeranthera canescens (hoary aster)	0.4	16
Plantago patagonica (Indian wheat)	1	40
Melilotus alba[a] (sweetclover)	X	X
Psoralea lanceolata (dune scurfpea)	X	X
Agropyron cristatum[a] (crested wheatgrass)	22.3	92
Achillea millefolium (yarrow)	0.3	12
Epilobium paniculatum (tall willowherb)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Poa sandbergii (Sandberg's bluegrass)	0.2	8
Eriogonum niveum (snow buckwheat)	X	X
Oeothera pallida (evening primrose)	0.2	8
Chrysothamnus nauseosus (gray rabbitbrush)	0.7	28
Descurainia pinnata (western tansymustard)	X	X
Oryzopsis hymenoides (Indian ricegrass)	X	X
Chrysothamnus viscidiflorus (green rabbitbrush)	X	X
Tragopogon dubius[a] (yellow salsify)	X	X
Hymenopapus filifolius (Columbia cutleaf)	X	X
Purshia tridentata (bitterbrush)	0.1	4
Stipa comata (needle-and-thread grass)	0.1	4
Festuca octoflora (slender sixweeks)	1.7	48
Astragalus caricinus (buckwheat milkvetch)	X	X
Artemisia tridentata (big sagebrush)	X	X
Chondrilla juncea[a] (Rush skeletonweed)	X	X
Biotic crust	10.6	44
Bare soil	25.8	100
Litter	21.7	100
Total cover (does not include crust, bare soil, or litter)	**51.6**	

[a] Introduced species.
X = present but not counted in plot frames

4.0 100 B/C AREA REVEGETATION

4.1 116-C-1 SITE

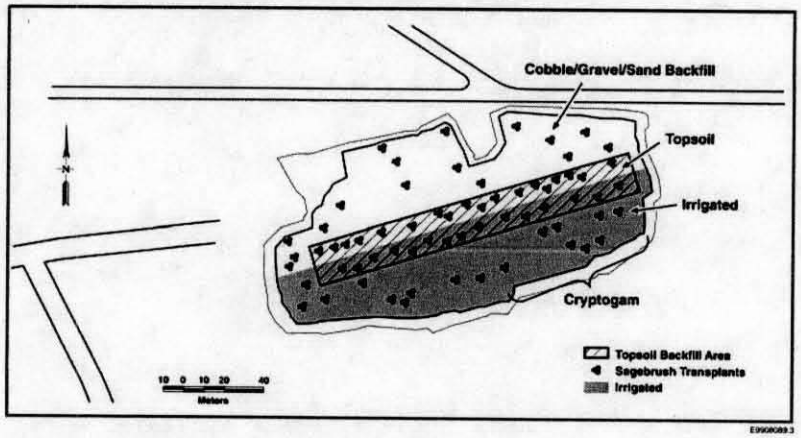
The 116-C-1 site was remediated as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action project for the 100-B/C Area (EPA et al. 1995). The goal of revegetating the remediated site was to stabilize the soils and initiate the establishment of native species. The restoration plan for the 116-C-1 site was developed as a demonstration project to evaluate the effects of soil type and supplemental irrigation on the establishment and success of native planted seeds and shrub seedlings.

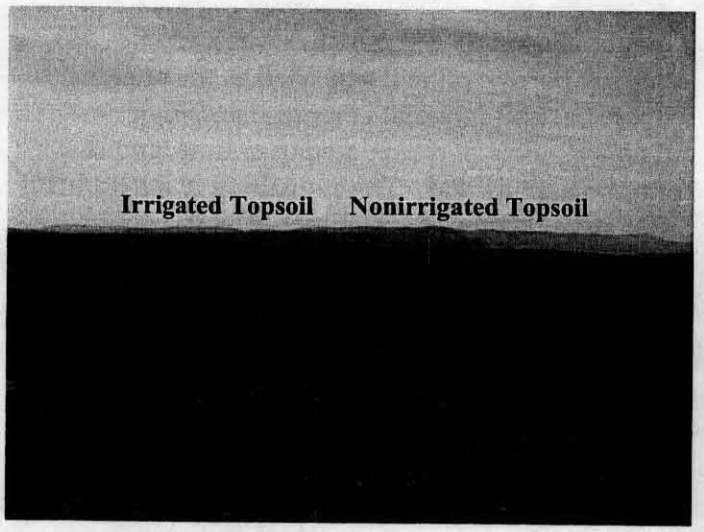
Four treatmentswere used on the backfilled site: irrigated cobble, irrigated topsoil, nonirrigated topsoil, and nonirrigated cobble. The backfill material used for remediation was a coarse assortment of cobble, gravel, and sand from a nearby borrow pit and was used as the planting medium for two of the four treatments. The cobble backfill material is representative of naturally occurring soils deposited by the Columbia River as it meandered over time, and is similar to backfill material that is used in other remediation areas. The remaining two treatments used fine-grained topsoil grubbed from the ERDF excavation in the summer of 1995. In November 1995, a seed mix of native species was planted across the four treatment areas (Weiss and Kemp 1998) (Figure 5). Sandberg's bluegrass (11.2 kg/ha), Indian ricegrass (2.2 kg/ha), and sagebrush (1.1 kg/ha) were planted using a range-type drill. Snow buckwheat (0.56 kg/ha), balsamroot (0.56 kg/ha), yarrow (0.28 kg/ha), needle-and-thread grass (1.1 kg/ha), and additional Indian ricegrass (0.28 kg/ha) were distributed across the site with a hand-operated broadcast seeder. To evaluate the effectiveness of promoting the early establishment of soil biotic crust, 9.1 kg of biotic soil/dust was hand broadcast over the eastern half of the site to inoculate the soil surface. Wheat straw was applied across the seeded area at a rate of 6.7 metric tons/ha and crimped with a disk. Two hundred and one sagebrush tublings were planted in groups of three across the four treatment areas. Irrigation was applied to one-half of the topsoil and one-half of the cobble substrate from March 15 through June 4, 1999, and from May 11 through June 26, 2000. The irrigation was applied in 30,283-L increments, with applications equivalent to approximately 5 cm (Table 5).

Table 5. Precipitation and Irrigation Received at the 116-C-1 Site Through 2003.

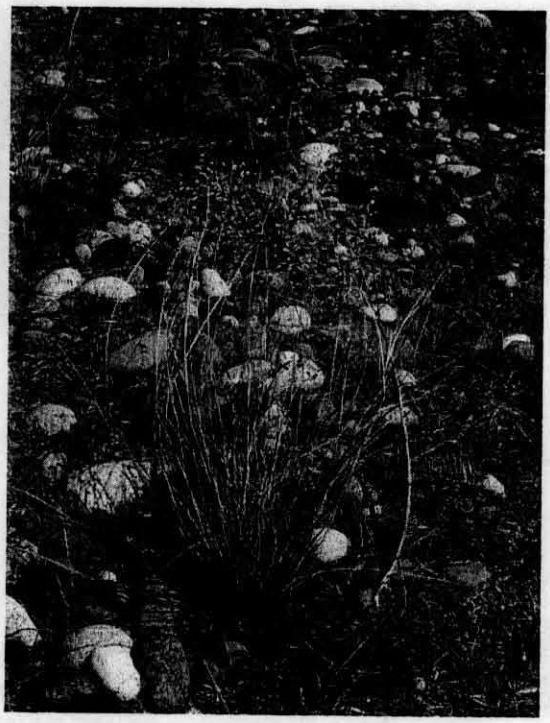
	Water (inches)						
	Irrigation 1999	**Irrigation 2000**	**Monthly Rainfall 1999**	**Monthly Rainfall 2000**	**Monthly Rainfall 2001**	**Monthly Rainfall 2002**	**Monthly Rainfall 2003**
March	0.37	0	0.06	0.94	0.67	0.19	0.26
April	0.83	0	Trace	0.57	0.83	0.29	2.23
May	0.67	0.98	0.34	0.77	0.08	0.16	0.08
June	0.44	1.18	0.31	0.25	1.27	0.65	Trace
Total	**2.31**	**2.16**	**0.71**	**2.53**	**2.85**	**1.29**	**2.57**

Figure 5. 116-C-1 Revegetation.

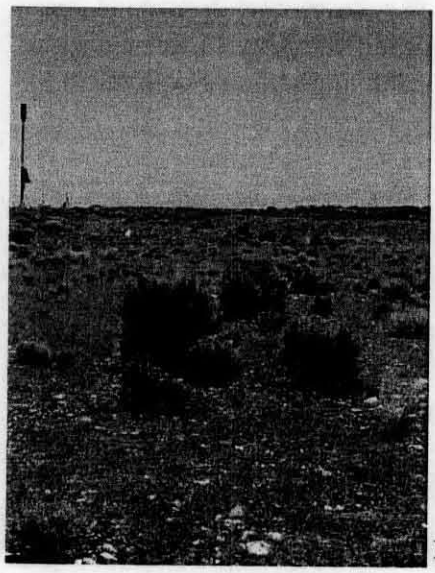




116-C-1 Topsoil, June 2003



Indian Ricegrass, Balsamroot, and Sandberg's Bluegrass on Nonirrigated Cobble, June 2003



Nonirrigated Cobble Sagebrush, June 2003

In June 2003, thirty-one species were identified on the site, the same number as observed in 2001. Total cover increased across all four treatment areas, with the greatest increase in cover occurring on the irrigated (19%) and nonirrigated (14.9%) topsoil treatment areas (Table 6). This increase on the topsoil areas is attributed to a greater density of tumblemustard (Table 7). Total cover increased on the nonirrigated (13.9%) and irrigated (9.8%) cobble treatment areas from 2002 data collections. While species diversity is greatest on the irrigated topsoil area with 24 species, it also has the greatest number of nonnative plants. Sagebrush survival deceased slightly across all four treatment areas this year, with shrub survival highest on the nonirrigated (93.9%) and irrigated (88.8%) cobble treatment, followed by the irrigated (71.9%) and nonirrigated (57.1%) topsoil treatment. Shrub survival across all four treatment areas is within acceptable rates with a site average of 77.6%. Despite lower sagebrush survivals, the planted sagebrush have produced seed for the last two years and, subsequently, sagebrush seedlings were noted across the cobble treatment areas. In addition to sagebrush producing seed, the needle-and-thread grass, Indian ricegrass, Sandberg's bluegrass, and snow buckwheat will also bloom this year. The establishment of these native species and the recruitment of seedlings indicates the revegetation effert has been successful and the goals have been met. Annual vegetation analysis across the four treatment areas suggests that importing topsoil and applying supplemental irrigation to revegetation areas does not increase native vegetation establishment, but rather promotes nonnative weedy species compared to the naturally occurring soils and natural precipitation treatment area.

Table 6. Percent Canopy Cover on the 116-C-1 Site in 2003.

Species	Non-Irrigated Cobble	Non-Irrigated Topsoil	Irrigated Topsoil	Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	21.6	10.8	10.4	7.9
Salsola kali[a] (Russian thistle)	0.3	0.4	0.3	0.3
Poa sandbergii (Sandberg's bluegrass)	8.3	16.1	23	8.7
Stipa comata (needle-and-thread grass)	0.9	0.6	0.2	0.3
Achillea millefolium (yarrow)	--	X	0.1	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	1.5	2.1	--
Artemisia tridentata (big sagebrush)	X	X	X	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	1.1	1.8	2.3	3.5
Descurania pinnata (western tansymustard)	--	0.6	0.5	--
Epilobium paniculatum (tall willowherb)	0.4	0.3	0.1	--
Eriogonum niveum (snow buckwheat)	2.8	--	0.6	2.8
Erodium cicutarium[a] (storksbill)	X	0.7	0.6	0.2
Lactuca serriola[a] (prickly lettuce)	--	--	X	--
Oryzopsis hymenoides (Indian ricegrass)	2.4	0.4	0.3	1.6
Sisymbrium altissimum[a] (tumblemustard)	0.4	18.8	12.6	0.2
Tragopogon dubius[a] (yellow salsify)	--	--	X	--
Machaeranthera canescens (hoary aster)	0.4	0.8	X	--
Astragalus sclerocarpus (stalked-pod milkvetch)	--	0.1	--	X
Centaurea diffusa[a] (diffuse knapweed)	0.1	0.1	0.2	0.1
Balsamorhiza careyana (Carey's balsamroot)	X	--	--	X
Erigeron poliospermus (cushion fleabane)	X	--	--	--
Erigeron piperianus (Piper's daisy)	0.1	--	--	--
Agropyron cristatum[a] (Crested wheatgrass)	0.3	--	0.6	0.4
Oenothera pallida (pale eveningprimrose)	--	X	--	--
Ambrosia acanthicarpa (bur ragweed)	X	0.3	0.3	--
Sphaeralcea munroana (Munro's globemallow)	--	--	--	X
Holosteum umbellatum[a] (jagged chickweed)	--	0.2	2	0.1
Agoseris heterophylla (mountain dandelion)	--	X	X	--
Draba Verna (Spring whitlow)	0.1	0.4	0.6	0.1
Purshia tridenta (bitterbrush)	X	--	--	--
Microsteris gracilis (pink microsteris)	--	--	0.4	--
Crust	--	3.4	10.2	--
Bare soil	37.8	30.3	25.5	36.2
Litter	28.1	30.7	38.2	16.3
Total cover (does not include crust, bare soil, or litter)	**39.2**	**53.9**	**57.2**	**26.3**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table 7. Percent Frequency of Occurrence on the 116-C-1 Site in 2003.

Species	Non-Irrigated Cobble	Non-Irrigated Topsoil	Irrigated Topsoil	Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	100	88	92	100
Salsola kali[a] (Russian thistle)	12	16	12	12
Poa sandbergii (Sandberg's bluegrass)	76	88	96	96
Stipa comata (needle-and-thread grass)	16	4	8	12
Achillea millefolium (yarrow)	--	X	4	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	40	24	0
Artemisia tridentata (big sagebrush)	X	--	--	4
Chrysothamnus nauseosus (gray rabbitbrush)	44	32	16	60
Descurania pinnata (western tansymustard)	--	24	20	--
Epilobium paniculatum (tall willowherb)	16	12	4	--
Eriogonum niveum (snow buckwheat)	16	--	4	16
Erodium cicutarium[a] (storksbill)	X	8	4	8
Lactuca serriola[a] (prickly lettuce)	--	--	X	--
Oryzopsis hymenoides (Indian ricegrass)	36	16	12	24
Sisymbrium altissimum[a] (tumblemustard)	16	88	96	8
Tragopogon dubius[a] (yellow salsify)	--	--	X	--
Machaeranthera canescens (hoary aster)	16	12	X	--
Astragalus caricinus (buckwheat milkvetch)	--	4	--	X
Centaurea diffusa[a] (diffuse knapweed)	4	4	8	4
Balsamorhiza careyana (Carey's balsamroot)	X	--	--	X
Erigeron poliospermus (cushion fleabane)	X	--	--	--
Erigeron piperianus (Piper's daisy)	4	--	--	--
Agropyron cristatum[a] (Crested wheatgrass)	12	--	4	16
Oenothera pallida (pale eveningprimrose)	--	X	--	--
Ambrosia acanthicarpa (bur ragweed)	X	12	12	--
Sphaeralcea munroana (Munro's globemallow)	--	--	--	X
Holosteum umbellatum[a] (jagged chickweed)	--	8	24	4
Agoseris heterophylla (mountain dandelion)	--	X	X	--
Draba verna (Spring whitlow)	4	16	24	4
Purshia tridenta (bitterbrush)	X	--	--	--
Microsteris gracilis (pink microsteris)	--	--	16	--
Crust	--	76	84	--
Bare soil	100	100	96	100
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

4.2 116-B-1, 116-B-11, AND 116-C-5 REVEGETATION SITES

The 116-B-1, 116-B-11, and 116-C-5 sites were also remediated as part of the CERCLA remedial action project for the 100-B/C Area (EPA et al. 1995). Initial revegetation efforts for these sites were completed December 9, 1999. The objective of revegetating these sites was to stabilize the soils while establishing a plant community dominated by native species, while limiting the number of introduced species within the community after establishment.

The material used to backfill the remediated waste sites was excavated from nearby Pit 24. The backfill material is representative of naturally occurring soils in the area and consists of rocky sand and gravel. The material placed as the top horizon of the remediated sites, and consequently the planting medium, was excavated from nutrient-deficient subsoil horizons within the pit. To compensate, three fertilizer treatments were applied on the backfilled sites to evaluate the results of the fertilizer applications and the establishment of the seeded native species.

On the southern half of the 116-B-11 site, a micronutrient fertilizer mixture containing sulfur (22.36%), soluble pot ash (1.6%), nitrogen (1.24%), magnesium (0.08%), zinc (0.24%), and boron (0.04%) was applied at a rate of 112 kg/ha. The northern half of 116-B-11 received Triple 16 fertilizer (16% each of nitrogen, phosphorous, and potassium) applied at a rate of 112 kg/ha. The 116-C-5 site received a combination of Triple 16 and micronutrient fertilizers applied at a rate of 112 kg/ha each. As a control site, no fertilizer was applied to the 116-B-1 site.

A native seed mix was broadcast with a hydroseeder across all sites. The seed mix and seeding rates included Sandberg's bluegrass (22.4 kg/ha), needle-and-thread grass (2.24 kg/ha), sagebrush (1.12 kg/ha), snow buckwheat (1.12 kg/ha), Carey's balsamroot (1.12 kg/ha), and yarrow (0.28 kg/ha). Small amounts of cushion fleabane (*Erigeron poliospermus*) and Piper's daisy (*Erigeron piperianus*) were also mixed in the hydroseeder and applied to the 116-C-5 site, but due to the small size and amount of seed, the quantities were not measured. Following the seeding, grass straw was applied as mulch across all of the seeded sites at a rate of 4.5 metric tons/ha.

The entire seeded area was irrigated with 0.62 cm of water. Half the water was applied through the hydroseeder during the application of seed and fertilizer mix. The remaining irrigation was applied after the distribution of the straw mulch.

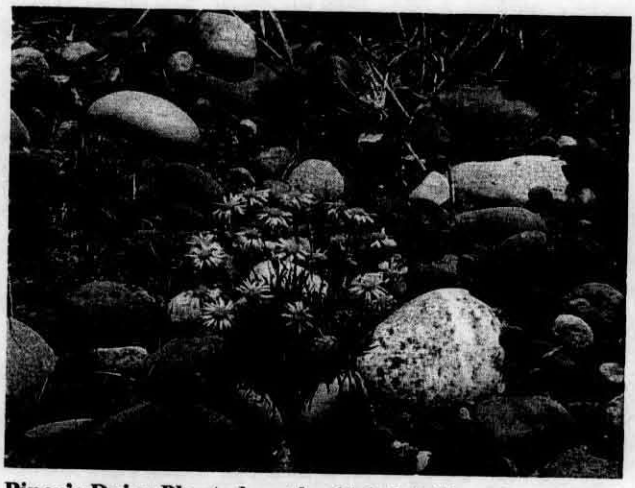
In December 2000, 2,600 sagebrush tublings were planted across the sites. Due to the rocky plant bed, planting holes were mechanically augured into the ground and filled with moist sand.

Fourth-year vegetation surveys were conducted in late May 2003. Twenty-nine species were observed across the sites, including 18 of which were native, and all 8 species that were broadcast seeded (Table 8). Total canopy cover increased across all four fertilizer treatment areas this year, with the greatest increase of 24.8% occurring on the Triple 16 fertilizer area, yielding a total cover of 46.3%. Species diversity remains highest on the 116-C-5 site, which received a combination of Triple 16 and micronutrient fertilizers, with 26 species identified,

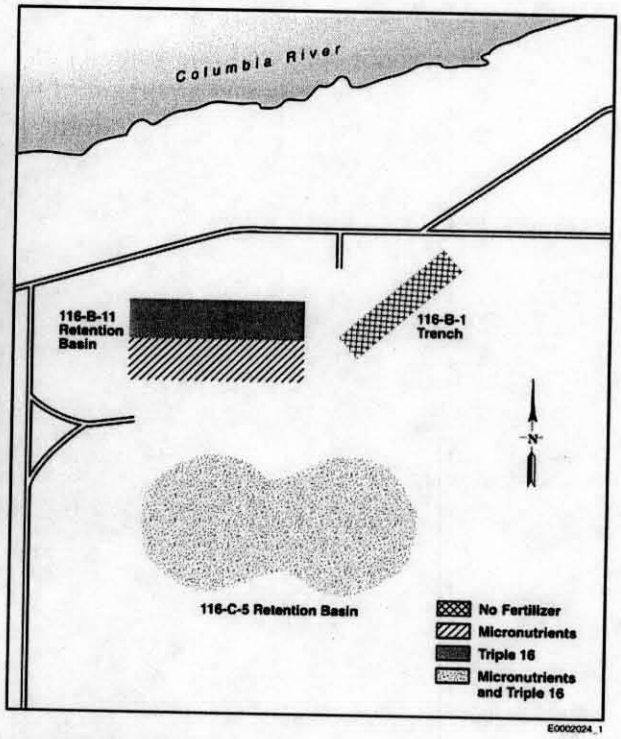
17 of which were native, followed by 20 species on both fertilizer treatments on the 116-B-11 site (Table 9). The Sandberg's bluegrass, needle-and-thread grass, snow buckwheat, Erigeron species, and sagebrush were all forming flower buds this year (Figure 6). Sagebrush survival data was not collected this year, as ongoing pipeline remediation projects in the vicinity of the revegetated sites removed a portion of the monitoring plot. Sagebrush throughout the site demonstrated mixed growth and vigor. Some plants were actively growing and forming flower buds, while others had not noticeably grown since their original installation in December 2000.

The planting method, time of year, and the weather appear to be contributing factors in the success of this revegetation effort. The weather was cool and applying water during and after the application of seed helped to distribute the seeds below the cobbles and increased germination. It also appears that the application of fertilizer during planting increased seedling survival. Germination of sagebrush seed was quite successful during this planting effort, also likely attributed to the cool moist conditions following the planting effort.

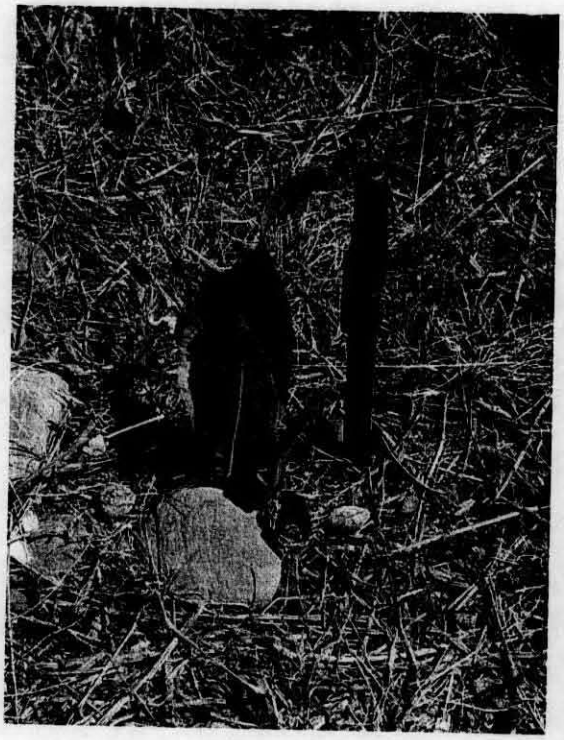
Figure 6. 116-B-1, 116-B-11, and 116-C-5 Revegetation Sites.



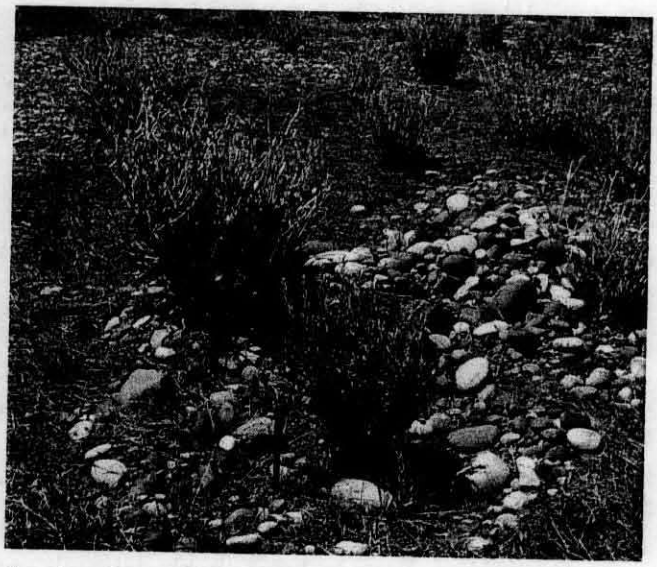
Piper's Daisy Planted on the 116-C-5 Site, May 2003



Fertilizer Treatments



Seeded Balsamroot on the 116-C-5 Site, May 2003



Sagebrush and Snow Buckwheat on the 116-B-11 Site, May 2003

Table 8. Percent Canopy Cover on the 100-B/C Revegetation Sites in 2003.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	28.0	26.3	21.9	4.9
Eriogonum niveum (snow buckwheat)	3.3	3.4	4.1	1.3
Salsola kali[a] (Russian thistle)	0.2	0.3	0.6	0.6
Achillea millefolium (yarrow)	1.0	0.4	0.4	0.1
Sisymbrium altissimum[a] (tumblemustard)	X	0.1	--	0.1
Descurainia pinnata (western tansymustard)	0.4	0.3	0.8	--
Centaurea diffusa[a] (diffuse knapweed)	X	0.1	X	X
Artemisia tridentata (big sagebrush)	0.3	0.3	0.2	--
Chrysothamnus nauseosus (gray rabbitbrush)	0.6	0.6	0.1	0.6
Chrysothamnus viscidiflorus (green rabbitbrush)	0.1	--	X	X
Balsamorhiza careyana (Carey's balsamroot)	0.1	X	X	X
Bromus tectorum[a] (cheatgrass)	2.3	8.2	4	15.1
Lactuca serriola[a] (prickly lettuce)	X	X	0.1	--
Machaeranthera canescens (hoary aster)	0.2	0.2	0.2	--
Epilobium paniculatum (tall willowherb)	0.1	0.4	0.3	0.3
Medicago sativa[a] (alfalfa)	X	0.1	X	X
Agropyron dasytachyum (thickspike wheatgrass)	0.8	--	--	--
Stipa comata (Needle-and-thread grass)	0.2	0.7	0.8	X
Tragopogon dubius[a] (yellow salsify)	0.1	--	0.1	--
Erigeron poliospermus (cushion fleabane)	X	X	--	--
Erigeron piperianus (piper's daisy)	X	--	--	X
Holosteum umbellatum[a] (jagged chickweed)	--	--	--	X
Vulpia myuros[a] (Rattail fesue)	X	0.6	--	0.4
Agropyron cristatum[a] (Crested wheatgrass)	X	0.3	--	--
Ambrosia acanthicarpa (bur ragweed)	--	--	X	--
Erodium cicutrium[a] (storksbill)	--	--	--	X
Agropyrom spicatum (bluebunch wheatgrass)	0.3	3.9	2.7	0.3
Festuca octoflora (six weeks fescue)	0.1	--	0.1	--
Sphaeralcea munroana (globemallow)	X	--	--	--
Bare soil	45.8	38.3	38.6	47.0
Litter	15.8	19.6	38.6	12.1
Total cover (does not include bare soil or litter)	**38.1**	**46.3**	**36.4**	**23.6**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table 9. Percent Frequency of Occurrence on the 100-B/C Revegetation Sites in 2003.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	96	100	96	95
Eriogonum niveum (snow buckwheat)	72	76	84	50
Salsola kali[a] (Russian thistle)	8	12	24	25
Achillea millefolium (yarrow)	40	16	16	5
Sisymbrium altissimum[a] (tumblemustard)	X	4	--	5
Descurainia pinnata (western tansymustard)	16	12	32	--
Centaurea diffusa[a] (diffuse knapweed)	X	4	X	--
Artemisia tridentata (big sagebrush)	12	12	8	--
Chrysothamnus nauseosus (gray rabbitbrush)	24	24	4	25
Chrysothamnus viscidiflorus (green rabbitbrush)	4	--	X	--
Balsamorhiza careyana (Carey's balsamroot)	4	X	X	--
Bromus tectorum[a] (cheatgrass)	52	80	64	100
Lactuca serriola[a] (prickly lettuce)	X	X	4	--
Machaeranthera canescens (hoary aster)	8	8	8	--
Epilobium paniculatum (tall willowherb)	4	16	12	10
Microsteris gracilis (annual phlox)	--	4	--	--
Medicago sativa[a] (alfalfa)	X	4	X	--
Agropyron dasytachyum (thickspike wheatgrass)	12	--	--	--
Stipa comata (Needle-and-thread grass)	8	8	12	--
Tragopogon dubius[a] (yellow salsify)	4	--	4	--
Erigeron poliospermus (cushion fleabane)	X	X	0	--
Erigeron piperianus (piper's daisy)	X	--	--	--
Vulpia myuros[a] (Rattail fesue)	X	4	--	15
Agropyron cristatum[a] (Crested wheatgrass)	X	12	--	--
Ambrosia acanthicarpa (bur ragweed)	--	--	X	--
Erodium cicutrium[a] (storksbill)	--	--	--	X
Agropyrom spicatum (bluebunch wheatgrass)	12	40	48	10
Festuca octoflora (six weeks fescue)	4	--	4	--
Sphaeralcea munroana (globemallow)	X	--	--	--
Bare soil	100	100	100	100
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

5.0 100-D/DR AND 100-H AREAS REVEGETATION

The 100-D/DR and 100-H liquid waste sites were remediated under the direction of the interim action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units (EPA et al. 1995). Remediation and backfill were completed at the 100-D/DR and 100-H Areas in the spring and summer of 2001. The remediated sites were revegetated in November and December 2001 in accordance with Tri-Party Agreement (EPA et al. 1998) Milestone M-16-26B. Twenty-four sites at the 100-D/DR Area (27.2 ha) and 12 sites (including the borrow area) at the 100-H Area (21.7 ha) were planted. The primary objective of this revegetation effort was to stabilize the soils while promoting the establishment of a vegetative community dominated by native species. Several species were added to the native seed mix to provide the area with a seed source. The establishment of these species will be observed in the annual vegetation monitoring program, and results will be documented and used to develop seed mixtures that will be successful in future revegetation efforts.

The backfill work at 100-D/DR was completed in the spring of 2001. A majority of the backfilled area was dominated by Russian thistle by the time the area was planted in December. Backfill operations for the 100-H Area sites were not completed until mid-summer and, as a result, the weedy species did not have an opportunity to become established on the remediated areas prior to seeding.

The backfill material used in the 100-D/DR and 100-H Areas was obtained from nearby borrow pits. As with most borrow areas, the material is excavated from several feet below grade and is nutrient-deficient. To help establish vegetation in these soils, a fertilizer mix of Triple 16 was co-applied during seeding at a rate of 112 kg/ha. A native seed mixture was broadcast across the sites with a hydroseeder. The seed mix included 22.4 kg/ha Sandberg's bluegrass, 2.24 kg/ha needle-and-thread grass, and small amounts of yarrow (*Achillea millefolium*), prairie clover (*Petalostemon ornatum*), sagebrush, rabbitbrush, Indian ricegrass, Carey's balsamroot, snow buckwheat, milkvetch, mariposa lily (*Calochortus macrocarpus*), grayball sage (*Salvia dorrii*), false yarrow (*Chaenactis douglasii*), slender hawksbeard (*Crepis atrabarba*), sanddrop seed (*Sporobolus cryptandrus*), fleabane, globe mallow (*Sphaeralcea munroana*), squirreltail grass, Cusick's sunflower (*Helianthus cusickii*), wallflower (*Erysimum asperum*), blazingstar (*Mentzelia laevicaulis*), spring parsely (*Cympopterus terebinthinus*), sand beardtongue, and long leaf phlox (*Phlox longifolia*). The entire seeded area was irrigated with 0.62 cm of water. One-half of the irrigation was applied during initial seeding, with the remaining irrigation applied immediately after seeding. Grass straw mulch was distributed across the entire seeded area at a rate of 4.5 metric tons/ha and crimped with a disk. Following the mulch application, 21,700, 4-in.^{3} sagebrush tublings were planted across the sites.

5.1 100-D/DR AREA SITES

Second-year vegetation surveys were conducted in May 2003. Thirty-six species were observed on the site this year, 7 more species than observed in 2002. Of the 36 species identified, 22 were native (Table 10), including 12 species that were included in the seed mix. This year the

revegetated area was dominated by cheatgrass with a 29% cover, followed by rattail fescue with a 23.8% cover. Sandberg's bluegrass cover was recorded at 4.7%, with a 43.3% frequency across the site. Russian thistle influence within the vegetative community has shown a significant reduction, down from 98% frequency recorded in 2002 to 40% frequency in 2003.

Sagebrush survival was estimated on a representative plot within the planted area in mid-May 2003 (Figure 7). Of the sagebrush counted, 87.8% were still alive in 2003, down from 93.8% observed in 2002. While the calculated sagebrush survival is down, the overall survival remains within acceptable rates. A majority of the planted seedlings did not show notable growth since their installation in December 2002.

5.2 100-H AREA SITES

Second-year vegetation surveys were conducted on the revegetated 100-H Area in mid-May 2003. Thirty species were identified across the revegetated area, of which 19 were native. Twelve of the planted species, including Sandberg's bluegrass, snow buckwheat, yarrow, sagebrush, rabbitbrush, needle-and-thread grass, squirreltail, false yarrow, and sand beardtongue, were observed on the sites. Rattail fescue dominated the area with 28.5% cover and 100% frequency (Table 11), followed by Sandberg's bluegrass with 3.7% cover, and cheatgrass with 3% cover. The entire area had a total cover of 38.1%, an increase of 6.8% from 2002 (Figure 8). The occurrence of rattail fescue was an unintended species that was present in the grass straw used as mulch. The grass straw was from a native seed production field and the intent was to capitalize on the residual native seed remaining the straw.

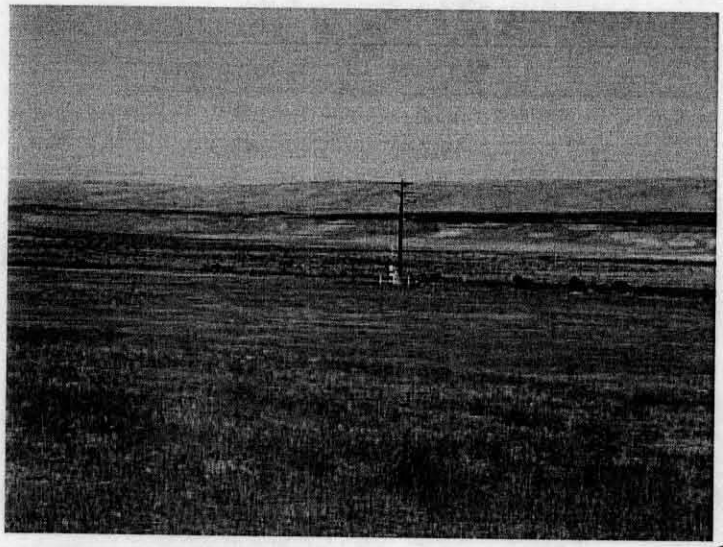
Sagebrush survival was evaluated within a representative plot on the remediated 116-H-7 site on May 14, 2003. Seedling survival remains consistent with 2002 survival data at 59%. Seedling vigor ranged from little to no notable growth on the sites backfilled with coarse soils containing cobbles. Sites that contained salvaged topsoil produced much healthier sagebrush with many palnts forming flower buds.

Table 10. Percent Canopy Cover and Frequency of Occurrence on the 100-D/DR Liquid Sites in 2003.

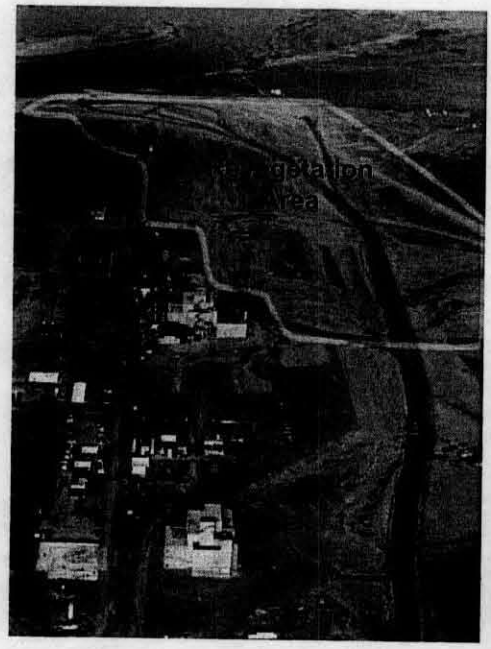
Species	% Cover	% Frequency
Vulpia myuros[a] (Rattail fescue)	23.8	80
Poa sandbergii (Sandberg's bluegrass)	4.7	43.3
Eriogonum niveum (snow buckwheat)	X	X
Salsola kali[a] (Russian thistle)	1	40
Achillea millefolium (yarrow)	0.5	20
Sisymbrium altissimum[a] (tumblemustard)	2.9	53.3
Amsinckia lycopsoides (tarweed fiddleneck)	1.8	6.7
Centaurea diffusa[a] (diffuse knapweed)	0.2	6.7
Artemisia tridentata (big sagebrush)	0.1	3.3
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	3.3
Chrysothamnus viscidiflorus (green rabbitbrush)	X	X
Erodium cicutrium[a] (storksbill)	0.2	6.7
Bromus tectorum[a] (cheatgrass)	29	93.3
Phaelia hastata (threadleaf scorpionweed)	X	X
Melilotus officinalis[a] (sweetclover)	X	X
Lactuca serriola[a] (prickly lettuce)	X	X
Machaeranthera canescens (hoary aster)	X	X
Epilobium paniculatum (tall willowherb)	0.2	6.7
Poa bulbosa[a] (bulbous bluegrass)	0.7	10
Draba verna (spring whitlow)	0.7	10
Stipa comata (Needle-and-thread grass)	X	X
Tragopogon dubius[a] (yellow salsify)	X	X
Lepidium perfoliatum[a] (clasping pepperweed)	0.2	6.7
Holosteum umbellatum[a] (jagged chickweed)	0.3	13.3
Chaenactis douglasii (hoary falseyarrow)	X	X
Ambrosia acanthicarpa (bur ragweed)	0.9	20
Sitanion hystrix (bottlebrush squirltail)	3.7	20
Festuca octoflora (slender sixweeks)	0.1	3.3
Hordeum leporinum[a] (Hare barley)	0.3	10
Taeniatherum asperum[a] (Medusahead)	0.1	3.3
Sphaeralcea munroana (globemallow)	0.1	3.3
Sporobolus cryptandrus (sanddrop seed)	X	X
Oryzopsis hymenoides (Indian ricegrass)	X	X
Agropyrom spicatum (bluebunch wheatgrass)	X	X
Penstemon acuminatus (sand beardtounge)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	X
Bare soil	38.5	100
Litter	49.1	100
Total cover (does not include bare soil or litter)	**71.3**	

[a] Introduced species.
X = present but not counted in plot frames

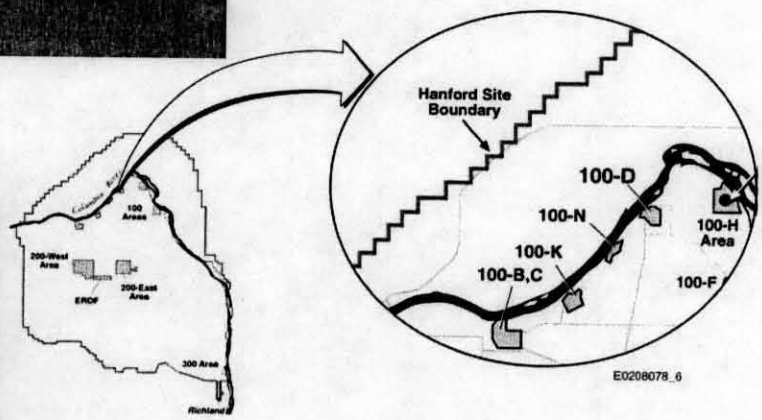
Figure 7. 100-D/DR Revegetation Sites.



Revegetated Area, May 2003



100-D/DR Revegetation Area, February 2001



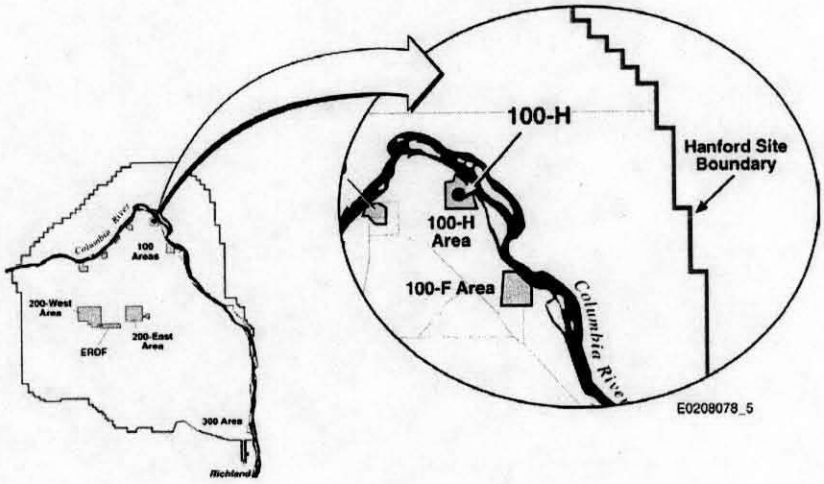
December 2001 Planted Sagebrush, May 2003

Table 11. Percent Canopy Cover and Frequency of Occurrence on the 100-H Revegetation Sites in 2003.

Species	% Cover	Frequency
Poa sandbergii (Sandberg's bluegrass)	3.7	68
Eriogonum niveum (snow buckwheat)	X	X
Salsola kali[a] (Russian thistle)	0.2	8
Achillea millefolium (yarrow)	0.1	4
Sisymbrium altissimum[a] (tumblemustard)	0.6	24
Descurainia pinnata (western tansymustard)	0.1	4
Artemisia tridentata (big sagebrush)	0.1	4
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Bromus tectorum[a] (cheatgrass)	3	60
Lactuca serriola[a] (prickly lettuce)	X	X
Machaeranthera canescens (hoary aster)	X	X
Epilobium paniculatum (tall willowherb)	0.1	4
Microsteris gracilis (annual phlox)	X	X
Poa bulbosa[a] (bulbous bluegrass)	0.6	4
Draba verna (spring whitlow)	0.2	8
Agropyron spicatum (Bluebunch wheatgrass)	0.7	8
Stipa comata (Needle-and-thread grass)	X	X
Tragopogon dubius[a] (yellow salsify)	X	X
Erigeron poliospermus (cushion fleabane)	X	X
Erigeron filifolius (threadleaf fleabane)	X	X
Holosteum umbellatum[a] (jagged chickweed)	0.1	4
Vulpia myuros[a] (Rattail fesue)	28.5	100
Erodium cicutrium[a] (storksbill)	X	X
Hordeum leporinum[a] (Hare barley)	X	X
Erysimum asperum (rough wallflower)	X	X
Ambrosia acanthicarpa (bur ragweed)	X	X
Lepidium perfoliatum[a] (clasping pepperweed)	X	X
Sitanion hystrix (bottlebrush squireltail)	X	X
Penstemon acuminatus (sand beardtounge)	X	X
Chaenactis douglasii (hoary falseyarrow)	X	X
Bare soil	34.3	88
Litter	49.7	96
Total cover (does not include bare soil or litter)	**38.1**	

[a] Introduced species.
X = present but not counted in plot frames

Figure 8. 100-H Revegetation Sites



Revegetated 116-H-7, May 2003

December 2001 Planted Sagebrush, May 2003

Sagebrush and Penstemon in the Revegetated Borrow Pit, May 2003

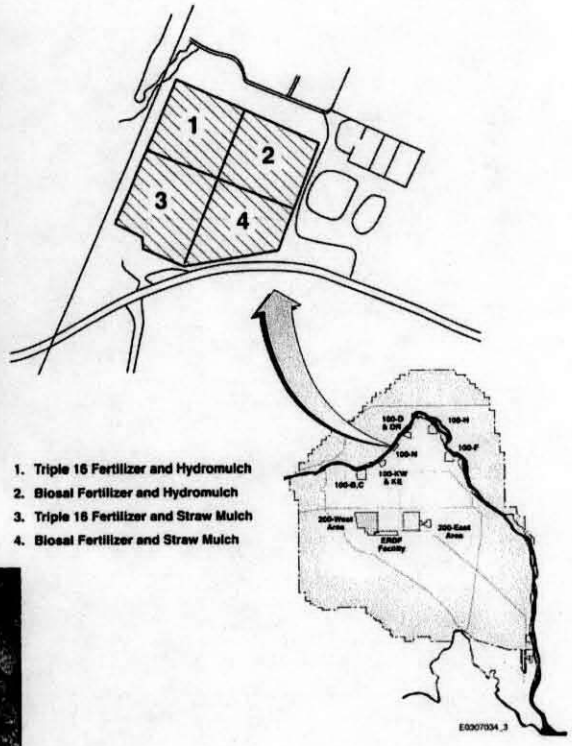
6.0 120-N-1 AND 120-N-2 SITES

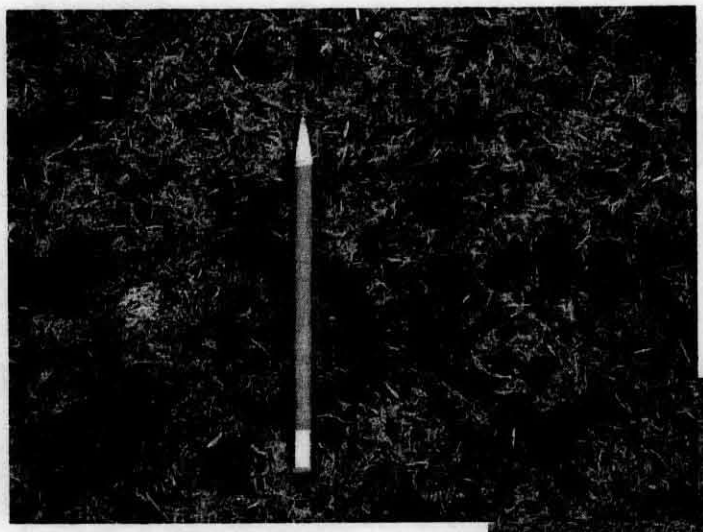
The 120-N-1 and 120-N-2 sites received process effluent from 1977 to 1988. The two sites were remediated as part of the interim action 100-NR-1 Treatment, Storage, and Disposal Units Record of Decision. Following remediation in the fall of 2002, the sites were backfilled to grade using material from a nearby borrow pit. In preparation for revegetation, the top 12.7 cm of the area to be seeded was ripped with a spring tooth-drawn implement. In mid-January 2003 the entire 1.6-ha area was broadcast seeded with 11.2 kg/ha Sandberg's bluegrass; 2.8 kg/ha Indian ricegrass; 2.8 kg/ha thickspike wheatgrass; 2.8 kg/ha bluebunch wheatgrass; 1.12 kg/ha needle-and-thread grass; 0.56 kg/ha sagebrush seed; 0.14 kg/ha yarrow; and small amounts of cushion fleabane, false yarrow, phlox, wallflower, and rabbitbrush seeds. One-half of the 1.6-ha area received 112 kg/ha of Triple 16 fertilizer coapplied during seeding, while the remaining area was treated with Biosol, an organic, slow-release fertilizer, at a rate of approximately 1,120 kg/ha (Figure 9). Upon completion of seeding and fertilizer application, the entire area was irrigated with 0.62 cm of water/ha. One-half of the Triple 16 fertilizer area and one-half of the Biosol-treated area was hydromulched with industry-standard mulch fiber. The remaining Triple 16 fertilizer area and Biosol-treated area were mulched with grass straw at approximately 4.5 metric tons/ha and crimped into the soil surface. Sagebrush tublings will be planted on the seeded area in the fall of 2005.

Vegetation surveys conducted on May 13, 2003 recorded 21 species on the site, including all 12 of the seeded species (Figure 10). Total cover is greatest in the Triple 16/straw mulch area with 18 species and 68% cover, followed by the Biosol/straw mulch area with 13 species and 44.1% cover (Table 12). The Triple 16/hydromulch area yielded 13 species and 29.1% cover, with 12 species and 18.5% cover in the Biosol/hydromulch area. Thickspike wheatgrass (*Agropyron dasytachyum*) dominated, with the greatest canopy cover and frequency of occurrence of all species planted, with the best germination occurring on the Triple 16 and straw mulch treatment area (Table 13). While initial vegetation analysis indicates germination success, first-year results are not always indicative of future performance.

Figure 9. 120-N Revegetation Sites.

Preremediation of 120-N Sites, June 2001



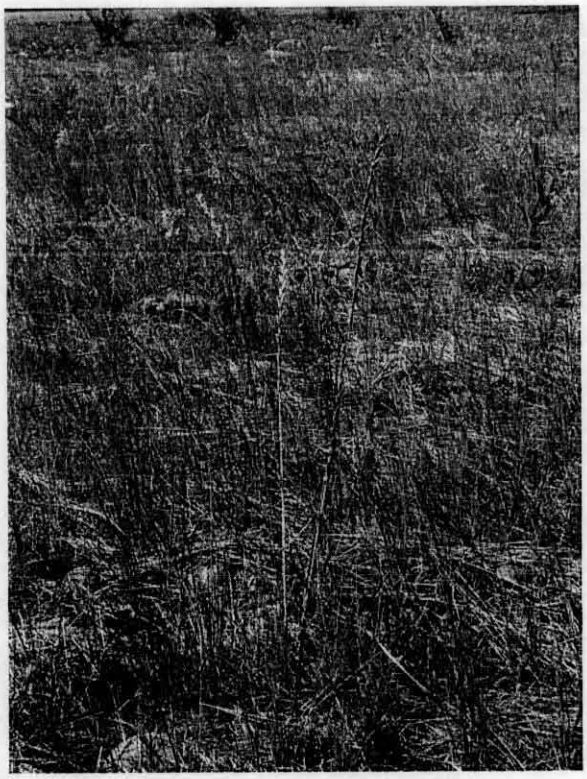


Hydromulch, January 2003

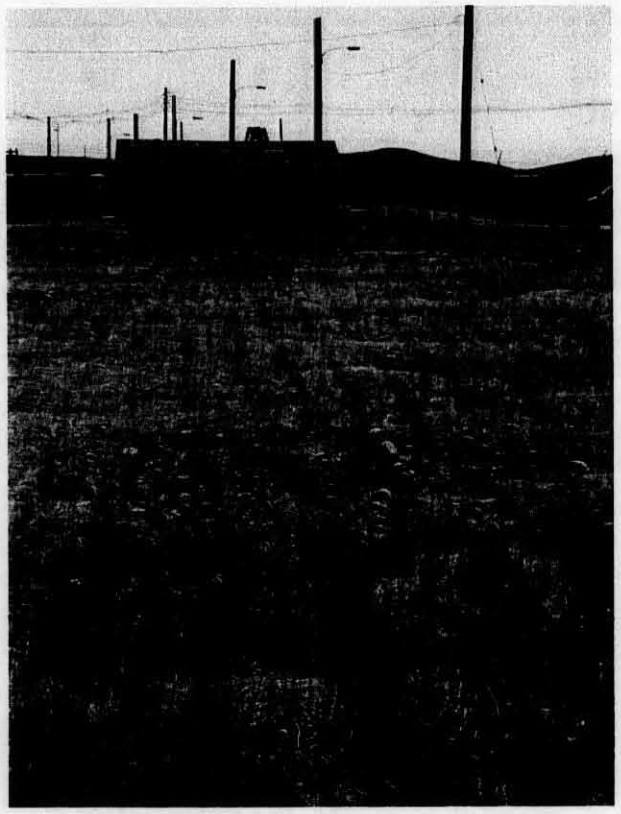
Straw Mulch, January 2003

Figure 10. 120-N Revegetation Sites.

Sagebrush, Yarrow, and Grass Seedlings, May 2003



Grass on the Triple 16 and Straw Mulch Treatment, May 2003



Grass Emerging on the Biosol and Straw Mulch Treatment, May 2003

Falseyarrow and Grass Seedlings on the Triple 16 and Hydromulch Treatment, May 2003

Table 12. Percent Canopy Cover on the 120-N-1 and 120-N-2 Sites in 2003.

Species	Triple 16 and Straw Mulch	Triple 16 and Hydromulch	Biosol and Straw Mulch	Biosol and Hydromulch
Argropyron dasytachum (thickspike wheatgrass)	35.4	13.1	31.4	2.6
Agropyron spicatum (Bluebunch wheatgrass)	1.9	0.8	0.4	X
Poa sandbergii (Sandberg's bluegrass)	16.0	4.4	3.4	X
Stipa comata (needle-and-thread grass)	0.6	--	0.3	--
Bromus tectorum[a] (cheatgrass)	0.8	0.9	0.4	0.6
Salsola kali[a] (Russian thistle)	3.4	7.1	4.1	14.3
Achillea millefolium (yarrow)	3.8	1.6	0.6	0.1
Vulpia myuros[a] (Rattail fesue)	4.5	--	1.3	--
Artemisia tridentata (big sagebrush)	0.5	0.1	0.1	X
Centaurea diffusa[a] (diffuse knapweed)	0.5	0.3	2.1	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	--	--	--
Lactuca serriola[a] (prickly lettuce)	X	--	--	--
Festuca octoflora (slender sixweeks)	0.1	--	--	--
Sisymbrium altissimum[a] (tumblemustard)	X	X	--	X
Machaeranthera canescens (hoary aster)	0.1	0.4	--	X
Chaenactis douglasii (hoary falseyarrow)	0.1	0.3	X	0.8
Phlox longifolia (longleaf phlox)	--	X	--	--
Amaranthus albus[a] (pigweed)	0.1	--	--	X
Erigeron poliospermus (cushion fleabane)	0.1	0.3	--	--
Oryzopsis hymenoides (Indian ricegrass)	--	--	0.1	--
Erysimum asperum (rough wallflower)	--	--	X	--
Bare soil	26.1	55.9	19.5	58.5
Litter	54.5	22.6	61.0	25.0
Total Cover (does not include bare soil or litter)	**68.0**	**29.1**	**44.1**	**18.5**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table 13. Percent Frequency of Occurrence on the 120-N-1 and 120-N-2 Sites in 2003.

Species	Triple 16 and Straw Mulch	Triple 16 and Hydromulch	Biosol and Straw Mulch	Biosol and Hydromulch
Argropyron dasytachum (thickspike wheatgrass)	100	95	100	80
Agropyron spicatum (Bluebunch wheatgrass)	25	30	15	X
Poa sandbergii (Sandberg's bluegrass)	85	75	60	X
Stipa comata (needle-and-thread grass)	25	--	10	--
Bromus tectorum[a] (cheatgrass)	30	10	15	25
Salsola kali[a] (Russian thistle)	85	90	65	90
Achillea millefolium (yarrow)	75	65	25	5
Vulpia myuros[a] (Rattail fesue)	55	--	25	--
Artemisia tridentata (big sagebrush)	20	5	5	X
Centaurea diffusa[a] (diffuse knapweed)	20	10	15	100
Chrysothamnus nauseosus (gray rabbitbrush)	5	--	--	--
Lactuca serriola[a] (prickly lettuce)	X	--	--	--
Festuca octoflora (slender sixweeks)	5	--	--	--
Sisymbrium altissimum[a] (tumblemustard)	X	X	--	X
Machaeranthera canescens (hoary aster)	5	15	--	X
Chaenactis douglasii (hoary falseyarrow)	5	10	X	5
Phlox longifolia (longleaf phlox)	--	X	--	--
Amaranthus albus[a] (pigweed)	5	--	--	X
Erigeron poliospermus (cushion fleabane)	5	10	--	--
Oryzopsis hymenoides (Indian ricegrass)	--	--	5	--
Erysimum asperum (rough wallflower)	--	--	X	--
Bare soil	100	100	95	100
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

7.0 ERDF MITIGATION

In December 2002, the U.S. Department of Energy, Richland Operations Office and the U.S. Fish and Wildlife Service cooperated on a compensatory mitigation planting project for the original construction of ERDF cells 1 and 2 on the Arid Lands Ecology Reserve (ALE). Approximately 68.8 ha of mature sagebrush habitat was lost during facility construction. The *Hanford Site Biological Resources Management Plan* (DOE-RL 2001) requires that if more than 1 ha (2.47 ac) of high-quality habitat is destroyed, then compensatory mitigation must take place at a rate of 3:1.

The ERDF mitigation project includes three separate planting elements: a native grass seeding, shrub seedling planting, and native grass plug planting (Figure 11). The native grass seed used in the seeding project was purchased from a local seed producer and derived from local sources. Prior to seeding approximately 64.8 ha with native grasses, an application of Roundup™ was aerial-applied to the project site in mid-November 2002. Following the aerial application, in mid-December 2002, 22.4 kg/ha of native grass seed mix consisting of Sandberg's bluegrass, thickspike wheatgrass, bottlebrush squirreltail, Indian ricegrass, and needle-and-thread grass was aerial broadcast, then harrowed with a tractor-drawn implement. An additional Roundup application was applied in mid-February 2003 to reduce cheatgrass competition to the seeded species. The broadcast-seeded area was visited in late May 2003. Grass seedlings were observed across the seeded area, and an increased seedling density was noted within the tractor tire tracks due to increased seed-to-soil contact.

Approximately 139,000 shrubs were planted across 125.5 ha in early December 2002. The shrubs planted included 10,300 10-in.^{3} tublings; 28,100 4-in.^{3}tublings; 93,000 bare root sagebrush; 6,000 green rabbitbrush tublings; and 6,000 gray rabbitbrush tublings. The bare root plants were dipped in mycorrhizal root gel prior to planting to help the plants acquire nutrients as they are getting established. The shrubs were planted in three separate areas and monitored for survival.

Additional ERDF mitigation plantings are anticipated for the fall and winter of 2003. That planting effort will include planting native grass and shrub plugs. Species to be planted will include Indian ricegrass, needle-and-thread grass, thickspike wheatgrass, antelope bitterbrush, and gray and green rabbitbrush.

All ERDF mitigation plantings will be monitored annually for plant establishment and shrub survival, and data collections will be included in the annual revegetation monitoring report.

Four monitoring plots were established within the sagebrush planting areas in the spring of 2003: two plots within Areas F and H, which were planted with bareroot seedlings, and two plots in Area I, one marked 10-in.^{3} sagebrush tublings and the other marked 4-in.^{3} planted sagebrush tublings. All plants within the monitoring plot were staked with an 18-in.-length of $^1/_2$-in.-diameter PVC pipe in early April in order to capture baseline plant survival. In

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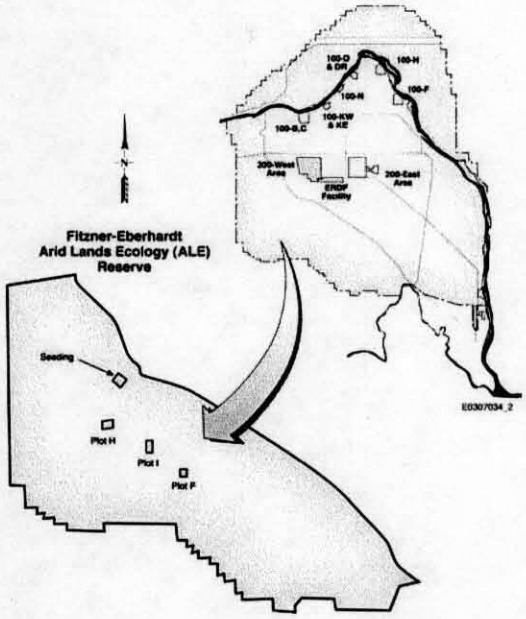
mid-August all marked plants were examined to estimate survival per seedling type. The bareroot plants had 57.9% survival; the 10-in.^{3} tublings had 65.6% survival, and the 4-in.^{3} tublings had 76.7% survival.

Figure 11. ERDF Mitigation on the ALE.

Sagebrush Planting Crew on the ALE, December 2002



4-in.^{3} Sagebrush Tubling, April 2003

Broadcast Seeded Grass, April 2003

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APPENDIX A

2002 REVEGETATION MONITORING RESULTS

Table A-1. Percent Canopy Cover and Frequency of Occurrence on the 600-23 Site in 2002.

Species	% Cover	% Frequency
Poa sandbergii (Sandberg's bluegrass)	3.7	88
Bromus tectorum[a] (cheatgrass)	0.4	16
Salsola kali[a] (Russian thistle)	2.4	76
Achillea millefolium (yarrow)	1.6	64
Melilotus alba[a] (sweetclover)	0.4	16
Eriogonum niveum (snow buckwheat)	0.2	8
Stipa comata (needle-and-thread grass)	0.2	8
Agropyron dasytacum (thickspike wheatgrass)	2.1	84
Artemisia tridentata (sagebrush)	0.1	4
Festuca octoflora (slender six-weeks)	0.1	4
Gilia leptomeria (Great Basin Gilia)	0.2	8
Sisymbrium altissimum[a] (tumble mustard)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	X	
Lactuca seriola[a] (prickly lettuce)	X	
Amsinckia lycopsoides (tarweed fiddleneck)	X	
Phacelia hastata (whiteleaf scorpionweed)	X	
Ambrisia acanthicarpa (bur ragweed)	X	
Poa bulbosa[a] (bulbous bluegrass)	X	
Chaenactis douglassii (hoary false yarrow)	X	
Purshia tridentata (bitterbrush)	X	
Mentzelia laevicaulis (blazing star)	X	
Bare soil	52.7	92
Litter (straw mulch)	25.3	96
Total cover (does not include bare soil or litter)	**11.5**	

[a] Introduced species.
X = present but not counted in plot frames

Table A-2. Percent Canopy Cover and Frequency of Occurrence on the J. A. Jones Site in 2002.

Species	% Cover	% Frequency
Argropyron dasytachum (thickspike wheatgrass)	32.1	100
Bromus tectorum[a] (cheatgrass)	6.2	72
Salsola kali[a] (Russian thistle)	11.7	100
Poa sandbergii (Sandberg's bluegrass)	2.2	88
Achillea millefolium (yarrow)	1.4	56
Amsinckia lycopsoides (tarweed fiddleneck)	1.2	48
Artemisia tridentata (big sagebrush)	X	X
Purshia tridentata (bitterbrush)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Eriogonum niveum (snow buckwheat)	X	X
Erodium cicutarium[a] (storksbill)	0.2	8
Lactuca serriola[a] (prickly lettuce)	X	X
Festuca octoflora (slender six-weeks)	0.4	16
Sisymbrium altissimum[a] (tumblemustard)	14	84
Machaeranthera canescens (hoary aster)	X	X
Chaenactis douglasii (hoary false yarrow)	0.3	12
Petalostemon ornatum (western prairieclover)	X	X
Microsteris gracilis (pink microsteris)	X	X
Penstemon acuminatus (sand beardtongue)	X	X
Balsamorhiza careyana (Carey's balsamroot)	0.1	4
Mentzelia laevicaulis (blazing star)	X	X
Plantago patagonica (Indian wheat)	X	X
Phlox longifolia (long-leaf phlox)	X	X
Oenothera pallida (pale evening primrose)	0.4	16
Ambrosia acanthicarpa (bur ragweed)	2.1	64
Draba verna (spring whitlowgrass)	0.3	12
Holosteum umbellatum[a] (jagged chickweed)	0.7	28
Melilotus officinalis[a] (sweetclover)	X	X
Amaranhus albus[a] (pigweed)	X	X
Bare soil	53.8	96
Litter	36.1	100
Total cover (does not include bare soil or litter)	**73.4**	

[a] Introduced species.
X = present but not counted in plot frames

Table A-3. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 2002.

Species	% Cover	% Frequency
Bromus tectorum[a] (cheatgrass)	17.3	100
Salsola kali[a] (Russian thistle)	0.8	32
Ambrosia acanthicarpa (bur ragweed)	0.1	4
Microsteris gracilis (annual phlox)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	2.2	68
Draba verna (spring whitlow)	1.2	48
Lactuca seriola[a] (prickly lettuce)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	2	40
Sisymbrium altissimum[a] (tumble mustard)	0.1	4
Erodium cicutarium[a] (storksbill)	3.5	60
Machaeranthera canescens (hoary aster)	0.1	4
Plantago patagonica (Indian wheat)	0.4	16
Melilotus alba[a] (sweetclover)	X	X
Psoralea lancedata (dune scurfpea)	0.6	4
Agropyron cristatum[a] (crested wheatgrass)	20.9	92
Achillea millefolium (yarrow)	X	X
Phacelia hastata (whiteleaf scorpionweed)	0.1	4
Poa sandbergii (Sandberg's bluegrass)	X	X
Eriogonum niveum (snow buckwheat)	0.6	4
Oeothera pallida (evening primrose)	0.2	8
Chrysothamnus nauseosus (gray rabbitbrush)	0.6	24
Poa bulbosa[a] (bulbous bluegrass)	0.1	4
Tragopogon dubius[a] (yellow salsify)	0.1	4
Hymenopapus filifolius (Columbia cutleaf)	X	X
Centaurea diffusa[a] (diffuse knapweed)	X	X
Chaenactis douglassii (hoary false yarrow)	X	X
Purshia tridentata (bitterbrush)	0.6	4
Stipa comata (needle-and-thread grass)	0.2	8
Festuca octoflora (slender six-weeks)	0.7	8
Astragalus caricinus (buckwheat milkvetch)	X	X
Centaurea solstitialis[a] (yellowstar thistle)	X	X
Chondrilla juncea[a] (Rush skeletonweed)	X	X
Biotic crust	6.1	68
Bare soil	37.3	100
Litter	39.3	100
Total cover (does not include crust, bare soil, or litter)	**52.5**	

[a] Introduced species.
X = present but not counted in plot frames

Table A-4. Percent Canopy Cover on the 116-C-1 Site in 2002.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	2.9	9.2	7.3	10.8
Salsola kali[a] (Russian thistle)	0.3	0.1	0.3	0.7
Poa sandbergii (Sandberg's bluegrass)	6.4	15.3	16.5	7.5
Stipa comata (needle-and-thread grass)	1.8	0.1	0.1	1
Achillea millefolium (yarrow)	0.1	--	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	1	2.3	--
Artemisia tridentata (big sagebrush)	0.1	1.6	0.2	X
Chrysothamnus nauseosus (gray rabbitbrush)	2.6	2.8	2.7	2.1
Descurania pinnata (western tansymustard)	--	0.3	0.3	--
Epilobium paniculatum (tall willowherb)	--	--	--	0.3
Eriogonum niveum (snow buckwheat)	0.3	0.6	X	0.5
Erodium cicutarium[a] (storksbill)	--	0.1	0.1	X
Lactuca serriola[a] (prickly lettuce)	--	0.1	0.3	X
Oryzopsis hymenoides (Indian ricegrass)	1	0.2	0.2	1.4
Sisymbrium altissimum[a] (tumblemustard)	0.4	5.9	7.5	0.3
Tragopogon dubius[a] (yellow salsify)	--	--	X	X
Machaeranthera canescens (hoary aster)	0.1	X	--	X
Centaurea diffusa[a] (diffuse knapweed)	0.1	X	--	0.1
Balsamorhiza careyana (Carey's balsamroot)	X	--	--	X
Erigeron poliospermus (cushion fleabane)	--	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
Agropyron cristatum (crested wheatgrass)	0.4	0.1	0.1	0.4
Oenothera pallida (pale eveningprimrose)	--	--	--	0.2
Ambrosia acanthicarpa (bur ragweed)	--	--	X	--
Holosteum umbellatum[a] (jagged chickweed)	--	0.5	0.4	--
Draba verna (spring whitlow)	--	0.3	0.6	--
Microsteris gracilis (annual phlox)	--	--	0.1	--
Agropyron dasytachyum (thickspike wheatgrass)	--	--	X	--
Crust	0.1	8.3	3.9	0.5
Bare soil	61.3	36.3	37.4	42.9
Litter	19.2	34.5	27.6	34.4
Total cover (does not include crust, bare soil, or litter)	16.5	38.2	39	25.3

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table A-5. Percent Frequency of Occurrence on the 116-C-1 Site in 2002.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	76	96	100	100
Salsola kali[a] (Russian thistle)	12	4	12	28
Poa sandbergii (Sandberg's bluegrass)	96	92	100	88
Stipa comata (needle-and-thread grass)	16	4	4	20
Achillea millefolium (yarrow)	4	--	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	20	32	--
Artemisia tridentata (big sagebrush)	4	8	8	X
Chrysothamnus nauseosus (gray rabbitbrush)	64	16	12	44
Descurania pinnata (western tansymustard)	--	12	12	--
Epilobium paniculatum (tall willowherb)	--	--	--	12
Eriogonum niveum (snow buckwheat)	12	4	X	20
Erodium cicutarium[a] (storksbill)	--	4	4	X
Lactuca serriola[a] (prickly lettuce)	--	4	12	X
Oryzopsis hymenoides (Indian ricegrass)	40	8	8	56
Sisymbrium altissimum[a] (tumblemustard)	16	96	100	12
Tragopogon dubius[a] (yellow salsify)	--	--	X	X
Machaeranthera canescens (hoary aster)	4	X	--	X
Centaurea diffusa[a] (diffuse knapweed)	4	X	--	4
Balsamorhiza careyana (Carey's balsamroot)	--	--	--	--
Erigeron poliospermus (cushion fleabane)	X	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
Agropyron cristatum (crested wheatgrass)	--	--	--	X
Oenothera pallida (pale eveningprimrose)	16	4	4	16
Ambrosia acanthicarpa (bur ragweed)	--	--	--	8
Holosteum umbellatum[a] (jagged chickweed)	--	--	X	--
Draba verna (spring whitlow)	--	20	16	--
Microsteris gracilis (annual phlox)	--	12	24	--
Agropyron dasytachyum (thickspike wheatgrass)	--	--	4	--
Crust	--	--	X	--
Bare soil	4	92	96	20
Litter	100	96	96	100
Total cover (does not include crust, bare soil, or litter)	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table A-6. Percent Canopy Cover on the 100-B/C Revegetation Sites in 2002.

Species	116-C-5	116-B-11	(16-16-16)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	18.5	14.4	12.6	3.7
Eriogonum niveum (snow buckwheat)	5.7	3.7	2.7	2
Salsola kali[a] (Russian thistle)	0.6	0.1	0.4	0.4
Achillea millefolium (yarrow)	0.9	0.6	0.2	0.3
Sisymbrium altissimum[a] (tumblemustard)	0.1	0.3	0.1	0.2
Descurainia pinnata (western tansymustard)	0.5	X	--	0.3
Centaurea diffusa[a] (diffuse knapweed)	X	0.1	X	X
Artemisia tridentata (big sagebrush)	0.4	0.3	0.2	X
Chrysothamnus nauseosus (gray rabbitbrush)	0.8	0.9	0.2	0.8
Chrysothamnus viscidiflorus (green rabbitbrush)	0.2	--	--	X
Balsamorhiza careyana (Carey's balsamroot)	0.2	0.1	X	0.1
Bromus tectorum[a] (cheatgrass)	1.0	2.2	1.2	5.4
Lactuca serriola[a] (prickly lettuce)	X	--	0.1	--
Machaeranthera canescens (hoary aster)	0.1	--	X	0.1
Epilobium paniculatum (tall willowherb)	0.3	0.5	--	0.4
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	0.1
Draba verna (spring whitlow)	--	0.1	--	0.1
Medicago sativa[a] (alfalfa)	X	--	0.1	X
Agropyron dasytachyum (thickspike wheatgrass)	2.4	1.9	3.2	1
Stipa comata (needle-and-thread grass)	0.2	--	0.2	0.1
Tragopogon dubius[a] (yellow salsify)	0.1	0.1	0.1	X
Erigeron poliospermus (cushion fleabane)	0.1	0.2	--	--
Erigeron piperianus (Piper's daisy)	0.1	--	--	--
Holosteum umbellatum[a] (jagged chickweed)	0.1	--	--	0.1
Agropyron cristatum[a] (crested wheatgrass)	X	0.3	0.1	0.1
Erodium cicutrium[a] (storksbill)	0.1	0.2	--	--
Chaenactis douglasii (hoary false yarrow)	X	--	--	--
Agastachea occidentalis[a] (western horsemint)	X	--	--	--
Bare soil	53.6	55	47.9	63.2
Litter	27.7	26.6	35.8	19.7
Total cover (does not include bare soil or litter)	**31.8**	**26.0**	**21.5**	**15.2**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table A-7. Percent Frequency of Occurrence on the 100-B/C Revegetation Sites in 2002.

Species	116-C-5	116-B-11 (Triple-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	100	100	100	88
Eriogonum niveum (snow buckwheat)	90	52	48	60
Salsola kali[a] (Russian thistle)	22	4	16	16
Achillea millefolium (yarrow)	36	24	8	12
Sisymbrium altissimum[a] (tumblemustard)	2	12	4	8
Descurainia pinnata (western tansymustard)	18	X	--	12
Centaurea diffusa[a] (diffuse knapweed)	X	4	X	X
Artemisia tridentata (big sagebrush)	16	12	8	X
Chrysothamnus nauseosus (gray rabbitbrush)	22	36	8	32
Chrysothamnus viscidiflorus (green rabbitbrush)	6	--	--	X
Balsamorhiza careyana (Carey's balsamroot)	8	4	X	4
Bromus tectorum[a] (cheatgrass)	40	48	48	96
Oryzopsis hymenoides (Indian ricegrass)	--	X	4	--
Melilotus officinalis[a] (sweetclover)	X	--	--	--
Lactuca serriola[a] (prickly lettuce)	X	--	4	--
Machaeranthera canescens (hoary aster)	2	--	X	4
Epilobium paniculatum (tall willowherb)	10	20	--	16
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	4
Draba verna (spring whitlow)	--	4	--	4
Medicago sativa (alfalfa)	X	--	4	X
Agropyron dasytachyum (thickspike wheatgrass)	46	56	68	20
Stipa comata (needle-and-thread grass)	8	--	8	4
Tragopogon dubius (yellow salsify)	2	4	4	X
Erigeron poliospermus (cushion fleabane)	2	8	--	--
Erigeron piperianus (Piper's daisy)	4	--	--	--
Holosteum umbellatum[a] (jagged chickweed)	2	--	--	4
Agropyron cristatum[a] (crested wheatgrass)	X	12	4	4
Erodium cicutrium[a] (storksbill)	2	8	--	--
Chaenactis douglasii (hoary false yarrow)	X	--	--	--
Agastachea occidentalis[a] (western horsemint)	X	--	--	--
Bare soil	98	100	96	100
Litter	98	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table A-8. Percent Canopy Cover and Frequency of Occurrence on the 100-D/DR Sites in 2002.

Species	% Cover	% Frequency
Poa sandbergii (Sandberg's bluegrass)	3.2	76
Salsola kali[a] (Russian thistle)	13.1	98
Achillea millefolium (yarrow)	0.4	16
Sisymbrium altissimum[a] (tumblemustard)	1.7	48
Descurainia pinnata (western tansymustard)	0.5	10
Amsinckia lycopsoides (tarweed fiddleneck)	0.3	12
Centaurea diffusa[a] (diffuse knapweed)	X	X
Artemisia tridentata (big sagebrush)	0.1	4
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	2
Chrysothamnus viscidiflorus (green rabbitbrush)	X	X
Erodium cicutrium[a] (storksbill)	X	X
Bromus tectorum[a] (cheatgrass)	2.9	58
Phaelia linearis (threadleaf scorpionweed)	X	X
Melilotus officinalis[a] (sweetclover)	X	X
Lactuca serriola[a] (prickly lettuce)	0.3	12
Machaeranthera canescens (hoary aster)	X	X
Epilobium paniculatum (tall willowherb)	0.1	2
Senecio vulgaris[a] (common groundsel)	X	X
Poa bulbosa[a] (bulbous bluegrass)	0.1	2
Draba verna (spring whitlow)	0.2	8
Agropyron dasytachyum (thickspike wheatgrass)	5.6	64
Stipa comata (needle-and-thread grass)	X	X
Lepidium perfoliatum (clasping pepperweed)	X	X
Holosteum umbellatum (jagged chickweed)	0.5	20
Mentzelia albicaulis (whitestem stickleaf)	X	X
Ranunculus testiculatus (bur buttercup)	0.3	12
Sphaeralcea munroana (globemallow)	0.1	2
Chaenactis douglasii (hoary false yarrow)	X	X
Ambrosia acanthicarpa (bur ragweed)	0.1	2
Bare soil	48.5	90
Litter	31.8	100
Total cover (does not include bare soil or litter)	**29.3**	

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table A-9. Percent Canopy Cover and Frequency of Occurrence on the 100-H Sites in 2002.

Species	% Cover	% Frequency
Poa sandbergii (Sandberg's bluegrass)	18.9	94
Eriogonum niveum (snow buckwheat)	X	X
Salsola kali[a] (Russian thistle)	1.9	74
Achillea millefolium (yarrow)	1.0	38
Sisymbrium altissimum[a] (tumblemustard)	1.5	30
Descurainia pinnata (western tansymustard)	0.1	2
Centaurea diffusa[a] (diffuse knapweed)	X	X
Artemisia tridentata (big sagebrush)	0.1	2
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Bromus tectorum[a] (cheatgrass)	2.3	44
Lactuca serriola[a] (prickly lettuce)	0.1	4
Machaeranthera canescens (hoary aster)	X	X
Epilobium paniculatum (tall willowherb)	0.1	2
Senecio vulgaris[a] (common groundsel)	X	X
Poa bulbosa[a] (bulbous bluegrass)	0.7	8
Draba verna (spring whitlow)	0.5	18
Agropyron sp. (wheatgrass)	4.1	60
Stipa comata (needle-and-thread grass)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	0.2	6
Hordeum murinum[a] (smooth barley)	X	X
Erodium cicutrium[a] (storksbill)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	X
Lepidium perfoliatum[a] (clasping pepperweed)	0.1	2
Sitanion hystrix (bottlebrush squirreltail)	0.1	2
Penstemon acuminatus (sand beardtongue)	X	X
Chaenactis douglasii (hoary false yarrow)	X	X
Bare soil	49.9	96
Litter	26.7	98
Total cover (does not include bare soil or litter)	**31.3**	

[a] Introduced species.
X = present but not counted in plot frames

Appendix A – 2002 Revegetation Monitoring Results

APPENDIX B

2001 REVEGETATION MONITORING RESULTS

Appendix B – 2001 Revegetation Monitoring Results

Table B-1. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 2001.

Species	% Cover	% Frequency
Bromus tectorum[a] (cheatgrass)	16.8	96
Salsola kali[a] (Russian thistle)	1.8	72
Ambrosia acanthicarpa (bur ragweed)	0.2	8
Microsteris gracilis (annual phlox)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	1.2	48
Draba verna (spring whitlow)	1.5	40
Lactuca serriola[a] (prickly lettuce)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	1	20
Sisymbrium altissimum[a] (tumblemustard)	0.6	24
Erodium cicutarium[a] (storksbill)	4.5	44
Machaeranthera canescens (hoary aster)	0.1	4
Plantago patagonica (Indian wheat)	0.2	8
Melilotus alba[a] (sweetclover)	0.3	12
Psoralea lanceolata (dune scurfpea)	X	X
Agropyron cristatum[a] (crested wheatgrass)	11.8	76
Achillea millefolium (yarrow)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Poa sandbergii (Sandberg's bluegrass)	X	X
Eriogonum niveum (snow buckwheat)	X	X
Oenothera pallida (evening primrose)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	X	X
Brodiaea howellii (Howell's clusterlily)	X	X
Phacelia linearis (threadleaf scorpionweed)	X	X
Tragopogon dubius[a] (yellow salsify)	X	X
Hymenopappus filifolius (Columbia cutleaf)	X	X
Centaurea diffusa[a] (diffuse knapweed)	X	X
Chaenactis douglasii (hoary falseyarrow)	X	X
Purshia tridentata (bitterbrush)	X	X
Stipa comata (needle-and-thread grass)	X	X
Biotic crust	0.7	28
Bare soil	61.1	96
Litter	26.9	100
Total (does not include biotic crust, bare soil, or litter)	**40.1**	

[a] Introduced species.

X = present but not counted in plot frames

Table B-2. Percent Frequency of Occurrence on the 116-C-1 Site in 2001.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	92	100	100	88
Salsola kali (Russian thistle)	48	24	12	40
Poa sandbergii (Sandberg's bluegrass)	84	80	84	56
Stipa comata (needle-and-thread grass)	12	X	X	4
Triticum spp.[a] (wheat)	--	--	--	X
Achillea millefolium (yarrow)	X	X	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	4	--
Artemisia tridentata (big sagebrush)	4	--	4	4
Chrysothamnus nauseosus (gray rabbitbrush)	60	16	X	16
Descurainia pinnata (western tansymustard)	--	4	24	4
Epilobium paniculatum (tall willowherb)	X	--	--	--
Eriogonum niveum (snow buckwheat)	4	--	X	4
Erodium cicutarium[a] (storksbill)	4	--	--	X
Lactuca serriola[a] (prickly lettuce)	--	X	--	X
Oryzopsis hymenoides (Indian ricegrass)	32	X	X	32
Sisymbrium altissimum[a] (tumblemustard)	8	44	68	--
Tragopogon dubius[a] (yellow salsify)	X	--	--	4
Machaeranthera canescens (hoary aster)	X	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	X	--	--
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	X
Centaurea diffusa[a] (diffuse knapweed)	X	X	--	X
Balsamorhiza careyana (Carey's balsamroot)	X	X	--	4
Sporobolus cryptandrus (sand dropseed)	4	--	--	4
Erigeron poliospermus (cushion fleabane)	--	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
Agropyron cristatum[a] (crested wheatgrass)	X	X	4	X
Oenothera pallida (evening primrose)	X	X	X	X
Ambrosia acanthicarpa (bur ragweed)	X	--	--	--
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	--
Agastache occidentalis (western horsemint)	X	--	--	--
Sphaeralcea munroana (Munro's globemallow)	X	--	--	--
Descurainia sophia[a] (flixweed)	--	X	--	--
Holosteum umbellatum[a] (jagged chickweed)	--	--	4	--
Mentzelia albicaulis (whitestem stickleaf)	--	--	X	--
Agoseris heterophylla (mountain dandelion)	--	--	X	--
Bare soil	92	84	88	96
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present onsite

Table B-3. Percent Canopy Cover on the 116-C-1 Site in 2001.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	14.2	54.9	65.2	11.8
Salsola kali[a] (Russian thistle)	1.2	0.6	0.3	1
Poa sandbergii (Sandberg's bluegrass)	9.9	26.3	13.6	7.2
Stipa comata (needle-and-thread grass)	0.3	X	X	0.1
Triticum spp.[a] (wheat)	--	--	--	X
Achillea millefolium (yarrow)	X	X	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	0.1	--
Artemisia tridentata (big sagebrush)	0.6	--	0.1	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	5.4	3.2	X	0.4
Descurainia pinnata (western tansymustard)	--	0.1	2.1	0.1
Epilobium paniculatum (tall willowherb)	X	--	--	--
Eriogonum niveum (snow buckwheat)	0.1	--	X	0.1
Erodium cicutarium[a] (storksbill)	0.1	--	--	X
Lactuca serriola[a] (prickly lettuce)	--	X	--	X
Oryzopsis hymenoides (Indian ricegrass)	0.8	X	X	3.6
Sisymbrium altissimum[a] (tumblemustard)	0.2	1.6	5.5	--
Tragopogon dubius[a] (yellow salsify)	X	--	--	0.1
Machaeranthera canescens (hoary aster)	X	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	X	--	--
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	X
Centaurea diffusa[a] (diffuse knapweed)	X	X	--	X
Balsamorhiza careyana (Carey's balsamroot)	X	X	--	0.1
Sporobolus cryptandrus (sand dropseed)	0.1	--	--	0.1
Erigeron poliospermus (cushion fleabane)	--	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
Agropyron cristatum[a] (crested wheatgrass)	X	X	0.1	X
Oenothera pallida (evening primrose)	X	X	X	X
Ambrosia acanthicarpa (bur ragweed)	X	--	--	--
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	--
Agastache occidentalis (western horsemint)	X	--	--	--
Sphaeralcea munroana (Munro's globemallow)	X	--	--	--
Descurainia sophia[a] (flixweed)	--	X	--	--
Holosteum umbellatum[a] (jagged chickweed)	--	--	0.1	--
Mentzelia albicaulis (whitestem stickleaf)	--	--	X	--
Agoseris heterophylla (mountain dandelion)	--	--	X	--
Bare soil	48.8	11.7	15.6	44.3
Litter	51.5	85.6	78.4	48
Total cover (does not include bare soil or litter)	**32.9**	**86.7**	**87.1**	**24.7**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present onsite

Table B-4. Percent Canopy Cover on the 100-B/C Revegetation Sites in 2001.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	34.5	24.8	17.4	6.9
Eriogonum niveum (snow buckwheat)	1.6	2.7	1.4	2.1
Salsola kali[a] (Russian thistle)	1.1	1.2	1.7	1.3
Achillea millefolium (yarrow)	1.8	0.1	0.1	0.1
Sisymbrium altissimum[a] (tumblemustard)	0.1	X	X	X
Descurainia pinnata (western tansymustard)	0.9	X	0.4	0.1
Centaurea diffusa[a] (diffuse knapweed)	X	X	--	X
Artemisia tridentata (big sagebrush)	0.5	0.6	0.1	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	0.5	0.3	0.1	0.2
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	0.1
Balsamorhiza careyana (Carey's balsamroot)	X	0.1	0.1	X
Bromus tectorum[a] (cheatgrass)	0.5	1.2	1.2	4.2
Lactuca serriola[a] (prickly lettuce)	X	0.2	X	X
Machaeranthera canescens (hoary aster)	X	X	X	X
Epilobium paniculatum (tall willowherb)	0.1	0.1	0.2	0.1
Poa bulbosa[a] (bulbous bluegrass)	1.6	X	--	0.1
Draba verna (spring whitlow)	--	--	--	--
Medicago sativa[a] (alfalfa)	X	X	X	X
Agropyron dasytachyum (thickspike wheatgrass)	4.0	3.1	3.6	3.9
Stipa comata (needle-and-thread grass)	0.4	0.1	0.2	0.1
Tragopogon dubius[a] (yellow salsify)	0.1	X	X	--
Erigeron poliospermus (cushion fleabane)	0.1	X	--	--
Erigeron piperianus (Piper's daisy)	X	--	--	--
Holosteum umbellatum[a] (jagged chickweed)	X	--	--	--
Vulpia myuros[a] (rattail fescue)	0.1	--	--	--
Daucus spp.[a] (carrot)	X	--	--	--
Hordeum leporinum[a] (hare barley)	X	--	--	--
Agropyron cristatum[a] (crested wheatgrass)	--	0.8	X	--
Ambrosia acanthicarpa (bur ragweed)	--	--	--	--
Erodium cicutarium[a] (storksbill)	--	--	--	X
Bare soil	63.0	49.8	41.3	73.2
Litter	35.7	43.1	43.5	22.1
Total cover (does not include bare soil or litter)	**47.5**	**35.3**	**26.5**	**19.3**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present onsite

Table B-5. Percent Frequency of Occurrence on the 100-B/C Revegetation Sites in 2001.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	92	96	92	68
Eriogonum niveum (snow buckwheat)	32	48	36	24
Salsola kali[a] (Russian thistle)	44	48	68	52
Achillea millefolium (yarrow)	22	4	4	4
Sisymbrium altissimum[a] (tumblemustard)	2	X	X	X
Descurainia pinnata (western tansymustard)	34	X	16	4
Centaurea diffusa[a] (diffuse knapweed)	X	X	--	X
Artemisia tridentata (big sagebrush)	10	24	4	4
Chrysothamnus nauseosus (gray rabbitbrush)	8	12	4	8
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	4
Balsamorhiza careyana (Carey's balsamroot)	X	4	4	X
Bromus tectorum[a] (cheatgrass)	20	28	28	72
Lactuca serriola[a] (prickly lettuce)	X	8	X	X
Machaeranthera canescens (hoary aster)	X	X	X	X
Epilobium paniculatum (tall willowherb)	2	4	8	4
Poa bulbosa[a] (bulbous bluegrass)	16	X	--	4
Medicago sativa[a] (alfalfa)	X	X	X	X
Agropyron dasytachyum (thickspike wheatgrass)	42	44	64	24
Stipa comata (needle-and-thread grass)	6	4	8	4
Tragopogon dubius[a] (yellow salsify)	4	X	X	--
Erigeron poliospermus (cushion fleabane)	2	X	--	--
Erigeron piperianus (Piper's daisy)	X	--	--	--
Holosteum umbellatum[a] (jagged chickweed)	X	--	--	--
Vulpia myuros[a] (rattail fescue)	2	--	--	--
Daucus spp.[a] (carrot)	X	--	--	--
Hordeum leporinum[a] (hare barley)	X	--	--	--
Agropyron cristatum[a] (crested wheatgrass)	--	12	X	--
Erodium cicutarium[a] (storksbill)	--	--	--	X
Bare soil	96	96	92	96
Litter	98	92	92	72

[a] Introduced species.
X = present but not counted in plot frames
-- = not present onsite

Appendix B – 2001 Revegetation Monitoring Results

APPENDIX C

2000 REVEGETATION MONITORING RESULTS

Appendix C – 2000 Revegetation Monitoring Results

Table C-1. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 2000.

Species	% Cover	% Frequency
Triticum spp.[a] (wheat)	X	X
Bromus tectorum[a] (cheatgrass)	14.4	76
Salsola kali[a] (Russian thistle)	6.7	72
Ambrosia acanthicarpa (bur ragweed)	0.2	8
Microsteris gracilis (annual phlox)	0.4	16
Holosteum umbellatum[a] (jagged chickweed)	15.3	80
Draba verna (spring whitlow)	6.6	36
Lactuca serriola (prickly lettuce)	0.2	8
Amsinckia lycopsoides (tarweed fiddleneck)	3	44
Sisymbrium altissimum[a] (tumblemustard)	1.2	28
Erodium cicutarium[a] (storksbill)	4.8	76
Machaeranthera canescens (hoary aster)	0.1	4
Plantago patagonica (Indian wheat)	0.2	8
Melilotus alba[a] (sweetclover)	X	X
Psoralea lanceolata (dune scurfpea)	X	X
Agropyron cristatum[a] (crested wheatgrass)	5	64
Epilobium paniculatum (tall willowherb)	0.1	4
Phacelia hastata (whiteleaf scorpionweed)	0.1	4
Poa sandbergii (Sandberg's bluegrass)	X	X
Eriogonum niveum (snow buckwheat)	X	X
Oenothera pallida (evening primrose)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Descurainia pinnata (western tansymustard)	0.1	4
Poa bulbosa[a] (bulbous bluegrass)	X	X
Brodiaea howellii (Howell's clusterlily)	X	X
Layia grandulosa (white-daisy tidytips)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	X
Centaurea diffusa[a] (diffuse knapweed)	X	X
Agoseris heterophylla (annual mountain dandelion)	X	X
Bare Soil	38.6	100
Litter	49.5	100
Total (does not include bare soil or litter)	**58.5**	

[a] Introduced species.
X = present but not counted in plot frames

Table C-2. Percent Canopy Cover on the 116-C-1 Site in 2000.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irr. Topsoil	Non-Irr. Cobble
Bromus tectorum[a] (cheatgrass)	2.2	38.2	47.7	6.1
Salsola kali[a] (Russian thistle)	0.7	0.6	1.1	1
Poa sandbergii (Sandberg's bluegrass)	6.8	24.7	13.9	2.4
Stipa comata (needle-and-thread grass)	0.3	--	--	--
Triticum spp.[a] (wheat)	0.1	X	X	0.3
Achillea millefolium (yarrow)	--	X	--	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	X	X
Artemisia tridentata (big sagebrush)	X	--	--	--
Chrysothamnus nauseosus (gray rabbitbrush)	--	0.1	X	0.2
Descurainia pinnata (western tansymustard)	--	0.1	0.9	0.1
Epilobium paniculatum (tall willowherb)	--	--	--	X
Eriogonum niveum (snow buckwheat)	1.2	X	--	X
Erodium cicutarium[a] (storksbill)	--	--	--	X
Lactuca serriola[a] (prickly lettuce)	X	--	--	X
Oryzopsis hymenoides (Indian ricegrass)	X	0.1	X	1.5
Sisymbrium altissimum[a] (tumblemustard)	0.3	3	3.6	0.3
Tragopogon dubius[a] (yellow salsify)	X	X	X	X
Machaeranthera canescens (hoary aster)	0.1	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	--	--	--
Layia grandulosa (white-daisy tidytips)	--	--	X	X
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	X
Centaurea diffusa (diffuse knapweed)	X	X	--	X
Medicago sativa[a] (alfalfa)	X	--	--	--
Bare soil	34.4	35.4	34.8	35.2
Litter	62.2	61.6	63.5	65
Total cover (does not include bare soil or litter)	**11.7**	**66.8**	**67.2**	**11.9**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table C-3. Percent Frequency of Occurrence on the 116-C-1 Site in 2000.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irr. Topsoil	Non-Irr. Cobble
Bromus tectorum[a] (cheatgrass)	68	96	100	72
Salsola kali[a] (Russian thistle)	28	24	44	40
Poa sandbergii (Sandberg's bluegrass)	92	88	80	76
Stipa comata (needle-and-thread grass)	12	--	--	--
Triticum spp.[a] (wheat)	4	X	X	12
Achillea millefolium (yarrow)	--	X	--	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	X	X
Artemisia tridentata (big sagebrush)	X	--	--	--
Chrysothamnus nauseosus (gray rabbitbrush)	--	4	X	8
Descurainia pinnata (western tansymustard)	--	4	16	4
Epilobium paniculatum (tall willowherb)	--	--	--	X
Eriogonum niveum (snow buckwheat)	8	X	--	X
Erodium cicutarium[a] (storksbill)	--	--	--	X
Lactuca serriola[a] (prickly lettuce)	X	--	--	X
Oryzopsis hymenoides (Indian ricegrass)	X	4	X	20
Sisymbrium altissimum[a] (tumblemustard)	12	64	64	12
Tragopogon dubius[a] (yellow salsify)	X	X	X	X
Machaeranthera canescens (hoary aster)	4	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	--	--	--
Layia grandulosa (white-daisy tidytips)	--	--	X	X
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	X
Centaurea diffusa (diffuse knapweed)	X	X	--	X
Medicago sativa[a] (alfalfa)	X	--	--	--
Bare soil	100	100	100	100
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table C-4. Percent Canopy Cover on the 100-B/C Revegetation Sites in 2000.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	11.9	9	5.7	3.3
Eriogonum niveum (snow buckwheat)	0.55	0.3	X	0.3
Salsola kali[a] (Russian thistle)	1	2	0.8	2
Achillea millefolium (yarrow)	1.6	0.8	0.4	X
Sisymbrium altissimum[a] (tumblemustard)	1	0.3	0.3	1.1
Descurainia pinnata (western tansymustard)	7.6	4.7	4	10.3
Centaurea diffusa[a] (diffuse knapweed)	0.05	X	--	--
Artemisia tridentata (big sagebrush)	0.15	0.4	0.1	1.6
Chrysothamnus nauseosus (gray rabbitbrush)	0.15	0.2	--	X
Balsamorhiza careyana (Carey's balsamroot)	0.05	X	X	--
Poa spp.[a] (residual from straw)	1.4	2.7	1.4	3.9
Bromus tectorum[a] (cheatgrass)	X	--	0.2	7.7
Oryzopsis hymenoides (Indian ricegrass)	--	--	0.1	--
Melilotus officinalis[a] (sweetclover)	X	--	--	--
Lactuca serriola[a] (prickly lettuce)	X	X	X	X
Machaeranthera canescens (hoary aster)	X	--	X	--
Epilobium paniculatum (tall willowherb)	X	0.1	X	X
Microsteris gracilis (annual phlox)	X	--	--	--
Amaranthus albus[a] (pigweed)	X	--	--	--
Senecio vulgaris[a] (common groundsel)	X	--	--	--
Draba verna (spring whitlow)	--	X	--	--
Bare soil	52.45	50.5	41.8	60.1
Litter	46.25	46.7	55.2	37.6
Total cover (does not include bare soil or litter)	**25.45**	**20.5**	**13**	**30.2**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table C-5. Percent Frequency of Occurrence on the 100-B/C Revegetation Sites in 2000.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	90	84	88	76
Eriogonum niveum (snow buckwheat)	22	12	X	12
Salsola kali[a] (Russian thistle)	40	40	32	60
Achillea millefolium (yarrow)	16	12	16	X
Sisymbrium altissimum[a] (tumblemustard)	20	12	12	24
Descurainia pinnata (western tansymustard)	34	16	28	64
Centaurea diffusa[a] (diffuse knapweed)	2	X	--	--
Artemisia tridentata (big sagebrush)	6	16	4	8
Chrysothamnus nauseosus (gray rabbitbrush)	6	8	--	X
Balsamorhiza careyana (Carey's balsamroot)	2	X	X	--
Poa spp.[a] (residual from straw)	26	48	36	20
Bromus tectorum[a] (cheatgrass)	X	--	8	56
Oryzopsis hymenoides (Indian ricegrass)	--	--	4	--
Melilotus officinalis[a] (sweetclover)	X	--	--	--
Lactuca serriola[a] (prickly lettuce)	X	X	X	X
Machaeranthera canescens (hoary aster)	X	--	X	--
Epilobium paniculatum (tall willowherb)	X	4	X	X
Microsteris gracilis (annual phlox)	X	--	--	--
Amaranthus albus[a] (pigweed)	X	--	--	--
Senecio vulgaris[a] (common groundsel)	X	--	--	--
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	--
Draba verna (spring whitlow)	--	X	--	--
Bare soil	92	88	88	84
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

APPENDIX D

1999 REVEGETATION MONITORING RESULTS

Appendix D – 1999 Revegetation Monitoring Results

Table D-1. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 1999.

Species	% Cover	% Frequency
Triticum spp.[a] (wheat)	10	100
Bromus tectorum[a] (cheatgrass)	6.25	100
Salsola kali[a] (Russian thistle)	8.5	100
Agropyron cristatum[a] (crested wheatgrass)	2	80
Ambrosia acanthicarpa (bur ragweed)	3	70
Microsteris gracilis (annual phlox)	0.5	20
Holosteum umbellatum[a] (jagged chickweed)	2.25	90
Draba verna (spring whitlow)	1.5	60
Lactuca serriola[a] (prickly lettuce)	1.5	60
Amsinckia lycopsoides (tarweed fiddleneck)	3.25	80
Sisymbrium altissimum[a] (tumblemustard)	4.5	80
Erodium cicutarium[a] (storksbill)	2.5	50
Machaeranthera canescens (hoary aster)	0.75	30
Plantago patagonica (Indian wheat)	1.75	70
Melilotus alba[a] (sweetclover)	0.25	10
Psoralea lanceolata (dune scurfpea)	0.25	10
Epilobium paniculatum (tall willowherb)	0.25	10
Phacelia hastata (whiteleaf scorpionweed)	0.25	10
Poa sandbergii (Sandberg's bluegrass)	X	
Eriogonum niveum (snow buckwheat)	X	
Oenothera pallida (evening primrose)	X	
Biotic crust	0	
Bare soil	64	
Litter	22.75	
Total cover (does not include biotic crust, bare soil or litter)	**49.25**	

[a] Introduced species.
X = present but not counted on plot frames

Table D-2. Percent Canopy Cover on the 116-C-1 Site in 1999.

Species	Irrigated Backfill	Irrigated Topsoil	Non-irrigated Topsoil	Non-irrigated Backfill
Bromus tectorum[a] (cheatgrass)	0.5	19.5	11.3	0.3
Salsola kali[a] (Russian thistle)	1.9	14.9	12.8	1.2
Poa sandbergii (Sandberg's bluegrass)	1.1	3.2	2.5	0.5
Stipa comata (needle-and-thread grass)	1.2	0.6	0.3	0.2
Triticum spp.[a] (wheat)	2.5	4.9	5.1	1.9
Achillea millefolium (yarrow)	X	--	X	--
Agropyron spp. (wheatgrass)	X	X	X	--
Ambrosia acanthicarpa (bur ragweed)	--	0.1	0.1	X
Amsinckia lycopsoides (tarweed fiddleneck)	--	--	0.1	--
Artemisia tridentata (big sagebrush)	X	X	X	--
Balsamorhiza careyana (Carey's balsamroot)	0.1	--	--	--
Chenopodium spp. (goosefoot)	--	--	0.1	--
Chrysothamnus nauseosus (gray rabbitbrush)	0.5	0.3	0.6	X
Descurainia spp. (tansymustard)	X	2.1	0.7	X
Epilobium paniculatum (tall willowherb)	0.2	0.1	--	X
Eriogonum niveum (snow buckwheat)	X	X	X	X
Erodium cicutarium[a] (storksbill)	--	--	--	X
Holosteum umbellatum[a] (jagged chickweed)	--	--	X	X
Lactuca serriola[a] (prickly lettuce)	X	0.1	0.1	0.1
Mentzelia albicaulis (whitestem stickleaf)	--	--	0.1	--
Oenothera pallida (evening primrose)	--	--	X	--
Oryzopsis hymenoides (Indian ricegrass)	--	X	X	--
Sisymbrium altissimum[a] (tumblemustard)	X	3.6	0.1	--
Tragopogon dubius[a] (yellow salsify)	--	--	0.1	0.1
Bare soil	20.5	19.4	19.1	42.3
Litter	71.8	69.9	70.9	52.6
Total cover (does not include bare soil or litter)	**8**	**49.4**	**34**	**4.3**

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table D-3. Percent Frequency of Occurrence on the 116-C-1 Site in 1999.

Species	Irrigated Backfill	Irrigated Topsoil	Non-irrigated Topsoil	Non-irrigated Backfill
Bromus tectorum[a] (cheatgrass)	20	88	68	12
Salsola kali[a] (Russian thistle)	76	76	88	48
Poa sandbergii (Sandberg's bluegrass)	44	48	60	20
Stipa comata (needle-and-thread grass)	48	24	12	8
Triticum spp.[a] (wheat)	80	56	64	76
Achillea millefolium (yarrow)	X	--	X	--
Agropyron spp. (wheatgrass)	X	X	X	--
Ambrosia acanthicarpa (bur ragweed)	--	4	4	X
Amsinckia lycopsoides (tarweed fiddleneck)	--	--	4	--
Artemisia tridentata (big sagebrush)	X	X	X	--
Balsamorhiza careyana (Carey's balsamroot)	4	--	--	--
Chenopodium spp. (goosefoot)	--	--	4	--
Chrysothamnus nauseosus (gray rabbitbrush)	20	12	24	X
Descurainia spp. (tansymustard)	X	24	8	X
Epilobium paniculatum (tall willowherb)	8	4	--	X
Eriogonum niveum (snow buckwheat)	X	X	X	X
Erodium cicutarium[a] (storksbill)	--	--	--	X
Holosteum umbellatum[a] (jagged chickweed)	--	--	X	X
Lactuca serriola[a] (prickly lettuce)	X	4	4	4
Mentzelia albicaulis (whitestem stickleaf)	--	--	4	--
Oenothera pallida (evening primrose)	--	--	X	--
Oryzopsis hymenoides (Indian ricegrass)	--	X	X	--
Sisymbrium altissimum[a] (tumblemustard)	--	28	4	--
Tragopogon dubius[a] (yellow salsify)	--	--	4	4
Bare soil	20	72	60	96
Litter	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Appendix D – 1999 Revegetation Monitoring Results

APPENDIX E

NAME CHANGES INCLUDED IN INTEGRATED TAXONOMIC INFORMATION SYSTEM

APPENDIX E

NAME CHANGES INCLUDED IN INTEGRATED TAXONOMIC INFORMATION SYSTEM

The following represents recent name changes for species mentioned in this report. The first name is that used in Hitchcock and Cronquist (1973), and the second name is the more recent version found in the Integrated Taxonomic Information System (ITIS 1998).

Agropyron spicatum	=	*Pseudoroegneria spicata ssp. spicata*
Chrysothamnus nauseosus	=	*Ericameria nauseosa* ssp. *nauseosa* var. *nauseosa*
Cymopterus terebinthinus	=	*Pteryxia terebinthina* var. *terebinthina*
Epilobium paniculatum	=	*Epilobium brachycarpum*
Festuca octoflora	=	*Vulpia octoflora* var. *octoflora*
Microsteris gracilis	=	*Phlox gracilis* ssp. *gracilis*
Oryzopsis hymenoides	=	*Achnatherum hymenoides*
Poa sandbergii	=	*Poa secunda*
Psoralea lanceolata	=	*Psoralidium lanceolatum*
Sitanion hystrix	=	*Elymus elymoides* ssp. *elymoides*
Stipa comata	=	*Hesperostipa comata* ssp. *comata*

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